THE AIMS AND PROBLEMS OF ENTOMOLOGY IN THE LIGHT OF THE XXIst SPECIAL CONGRESS OF THE COMMUNIST PARTY OF THE SOVIET UNION

Our country is entering a new phase of its development. The historic decisions made at the XXIst Special Congress of the Communist Party of the Soviet Union will lead to a terrific construction program within Communist Society – a program of new and powerful advances in economic prosperity, culture and material welfare of the Soviet peoples. Between 1959 and 1965 the volume of industrial productivity is to be increased by 80%; and agricultural productivity is to be increased 1.7-fold. In this way we shall bring about a decisive transformation and controlled development within the material and technical basis of communism.

The developmental schemes which have been planned for all branches of our country's agriculture are possible only in as much as they are founded on broad applications of scientific and technical principles. In the highest stages of development of human society, the importance of science and technology attains its peak. The Seven Year Plan provides for an extensive program of scientific research, and a concentration of energy and effort on those investigations, having most important theoretical and practical importance.

The biological sciences are confronted by the greatest of these problems. In the provisional draft relating to the development of our natural economy within the USSR during the years 1959-1965, which was unanimously adopted by the XXIst Special Congress of the Soviet Communist Party, it is recorded that the development of biology is "a necessary theoretical foundation for the erection of medical science and also the agricultral sciences" and that "the important complex of the biological sciences will undergo a particular expansion in relation to its utilization of physical and chemical discoveries". This especially applies to the disciplines of entomology and acarology – two distinct sections of the general biological complex.

Insects and acarines constitute the most important component of the terrestrial, subterranean and freshwater biocenoces. Their part in the different processes which go on in the biosphere is enormous. They consume a vast quantity of both green and woody parts of plants, together with products of both plant and animal origin; when they die and decompose they participate in the general cycle of matter and energy which goes on in the soil and water; they pollinate flowering plants, transmit various plant and animal diseases caused by viruses, bacteria, fungi and other parasites, e.g., protozoa and parasitic worms. Many insects are themselves parasites of man and animals.

Insects are of great importance to various branches of our national agricultural and public health activities. The Seven Year Plan lays down that agricultrual output in the USSR must be greater, per 100 hectares, than for a comparable area in the USA; which means that, in the main, crop-productivity has to be increased. It is well known that a considerable loss in crop orpduction is due to insect predators; the overcoming of this destruction by insects "would create a considerable surplus to the yield from agricultural effort".

The organization of an attack against crop predators is possible only on the basis of a considerable amount of foresight and planning. The most important task before agricultural entomologists, therefore, is the attainment of a scientifically based prognosis of the multiplication of insect pests and in the light of this, to organization combative and protective measures capable of preventing or limiting that multiplication. Great attention must be paid to such mass predators as locusts, pentatomid bugs, corn borers, stem borers, wireworms, cotton owlet moth and certain others. Those insects which attack grain crops merit particular attention in relation to control measures employed against them, for the Seven Year Plan lays down that the principal trend of agricultural development in the immediate future must be toward a general increase in the production of grain, as this is the basic crop upon which so much other agricultural productivity depends.

The unexpected plague of grey owlet moths in Kazakhstan during 1957 among cereal crops grown on land which had previously been fallow shows, that so far, our knowledge of the possible emergence of new predators as a result of ploughing up arable land for the sowing of spring wheat is still quite inadequate. Another extremely important cereal crop, maize, has been badly attacked in the North by Swedish flies and the larvae of Elaterid beetles, and in the cotton growing districts of the south the maize fields have acquired a considerable importance as reservoirs of infestation for the cotton owlet moth. These examples show that new agricultural ventures and novel conditions of cultivation confront the agricultural entomologist with a series of new problems.

Chemical methods of insect control are of basic importance in the reduction of numbers of insect pests under the new Seven Year Plan. The text of the document relating to the development of our national economy in the USSR during 1959-1965 states that "as result of the ever-increasing expansion of the chemical industry there exist great opportunities during the next seven years for the perfecting the methods of defense against the predators and diseases of agricultural plants". In addition, to the extensive utilization of chemical methods for the destruction of insect pests which requires thorough investigation of their toxicology, methods of assay, and formulation of toxic materials, there is need for further research into protective methods of agricultural practice and methods of biological control. The planning of control by entomophagous predators which is based on careful choice of suitable methods for their introduction and dispersal throughout the control territory and of an evaluation of their effectiveness under field conditions, demands an extensive program of scientific research, which is closely related to agricultural productivity.

The silk-producing industry is faced with a considerable responsibility for development; by 1965 the required increase in production of mulberry-silk cocoons will be as follows: 1.2-fold increase for Azerbaidzhan, 1.6-fold for Armenia, 2.2-fold for Kirghizia, 1.5-fold for Tadzhikistan, 1.2-fold for Turkmen and 1.3-fold for Uzbekistan. This will require most careful selection of work and a general improvement in methods of silkworm raising. The problem of the situation of mulberry plantations, in places where they will be free from webworm attack, has not yet been resolved.

The control figures provide for very important improvements in forestry. In the timber producing regions of the North – the Urals and Siberia–, a very considerable expansion of afforestation is to take place, involving the sowing and planting of trees over an area of 11 million heactares, " the urgent task is to improve the quality of the timber produced, and to carry out work on the protection of timber against fire and insect pests." The task before the forestry entomologists must be the securing of a scientifically based prognosis of the multiplicative capacity of such mass predators of forest trees as gypsy moth larvae, pine and Siberian webworms, pine sawflies together with a large number of other pests attacking the bark, wood and seed of forest trees. In the Southern regions of timber cultivation the problem is not merely to improve the production of timber by planting large areas of young trees and protecting them from predator attack, but to determine the importance of timber plantations as places in which various agricultural pests may find secure retreats.

In the field of animal husbandry the Seven Year Plan foresees an increase in meat production to the extent of a mean annual value of more than 1 million, 100 thousand tons. This will demand, together with the necessary increase in available feeding stuffs, housing accomodation, and pasture maintenance, an improvement in veterinary services. Taking into account the enormous damage which is regularly sustained by animal husbandry as a result of attacks by various oestrid-flies, – damage to the skin, the nasopharynx and intestines –, and also the part played by diptera and ticks as vectors of protozoan and virus diseases, it is evident that there is a very considerable need for the formulation of measures designed to reduce the losses resulting from insect attack.

One of the most important tasks before medical entomologists is the battle against such biting insects as mosquitoes, blackflies, and gadflies. Although in recent years the bionomics of such pests has been the subject of much research, effective methods of protecting human beings and domestic animals against them have not yet been worked out with any degree of success. The working out of protective methods against bloodsucking arthropods is particularly important for the wooded areas of Siberia and the Far Eastern Republics, as was pointed out in a speech by Academician Lavrent'ev at the XXIst Congress of the Communist Party of the USSR. Individual protection by means of repellants is needed, together with improved means of effectively controlling the reproduction of bloodsucking insects in the taiga and other regions, especially methods which will destroy the larval stages of blackflies in rivers.

We must not overlook the problem of malaria. Although, in effect, the incidence of primary malaria has dropped throughout the Soviet Union in recent years, nevertheless experiments in other spheres, e.g., the control of agricultural pests,such as locusts, indicate quite clearly that any relaxation in the battle against the malarial parasite and its vectors, the anopheline mosquitoes, would result in the disease flaring up once again.

One problem is of great importance in relation to the exploitation of the natural resources of such regions as Siberia, Kazakhstan and the Far Eastern Republics; it is the further investigation of natural reservoirs of those diseases which are transmitted to man by insects and ticks from members of the native fauna in newly opened-up territories or where man is in close contact with natural coenoses. In this field may be listed the evolution of control measures against ixodid ticks, vectors of Taigan encephalitis; the combating of the recently discovered Q fever; methods of control against populations of rodents, particularly in regions where tularemia and other dangerous infections are endemic. The problem of leishmaniosis in Central Asia, a disease transmitted by various species of mosquitoes, is still far from solved at the present time. The need for studying natural reservoirs of disease which might spread both to the European parts of USSR and to neighboring countries is obvious.

The great tasks, therefore, which confront agricultural, forestry, veterinary and medical entomologists require an extension and intensification of researches throughout the whole field of general entomology, in such aspects as systematics, morphology, ontogeny, ecology, zoogeography and the paleontology of insects.

The study of the insect fauna of the Soviet Union is still far from complete. Every year new species unknown to science are discovered, many of which may prove tc be agricultural pests or pests of timber. In Siberia, where agricultural practice is closely associated with the felling of enormous quantities of timber, completely new insect coenoses are formed, the different members of which, though apparently of no economic importance initially, may become serious pests as has already happened in the case of the gray corn owlet moth in northern and central Kazakhstan.

Prognoses regarding the multiplicative potential of pests must be founded not merely on the basis of a profound knowledge of their population dynamics but also on widely based investigations into faunistic developments, ecology and ecologicophysiology of the pest in question. Great importance must also be attached to intraspecific geographical variability, as the initial stage in divergence, whereby populations in different parts of the area of distribution for a species may become qualitatively polymorphic.

The resolution of so many important practical problems at the present time is held up because of an insufficiency of knowledge about the basic principles of insect ecology. Such fields as insect behavior, physiological adaptation, neurohormonal regulation, sensory physiology, nutritional specilizations, together with insect genetics, population dynamics, etc., all require considerable attention with a view to enlarging our existing knowledge and perfecting our experimental techniques. It must be remembered that in all these fields, we are lagging behind the most highly developed capitalist countries as regards laboratory accommodation at the present time.

In order to develop biological methods of controlling insect pests,it is necessary to have complete knowledge of which insects feed upon them. Although such parasitic groups as the Proctotrupoidea, Pteromalidae, etc., are of real importance as a potential source of agents for the biological control of insect pests, so far their species have been incompletely determined within the territory of the USSR. Host — parasite relationships, except for a few insect pests, are quite unknown.

During the nest seven years great attention will have to be paid to the publication of the necessary literature. First of all, definitive taxonomic works such as those of the "Fauna of the USSR" will require expansion with respect to their treatment of the insect groups; as will regional faunistic works, especially abridged identification keys for the use of agronomists, veterinarians, medical personnel and teachers. In addition, as our biological knowledge of particular insect or acarine species accumulates, it will be necessary to plan the publication of separate monographs to cover a limited field. The controlling of epizootics and attacks by insect pests also requires a series of appropriate publications, particular in the statistical field.

The problem of entomological personnel is an acute one. The total number of entomologists employed at the present time in scientific institutions, in plant protection stations, in regional laboratories and at strategic points in connection with outbreaks of pests is clearly insufficient. Our specialist entomological personnel em-

ployed in both agriculture and public health are inferior in numbers to those of other countries. The task confronting us, therefore, is that of producing an all-around increase in productivity and this demands that agricultural crops and standing timber should be protected from attacks by predators; which can only be achieved if sufficient agricultural entomologists and forest pathologists are available to carry out adequate supervision of the territory under their care. More personnel must be forthcoming in order to serve agriculture and forestry in the business of plant protection.

The number of students studying plant protection science, at the present time, in agricultural colleges and in entomological departments of the universities does not meet the growing need of our national economy for specialst entomologists. The Seven Year Plan lays down that the output of specialists who have attained the highest educational levels must be increased 1.4-fold as compared with the period 1952-1958. In order that entomologists may hold their own numerically among the other scientific specialists, the number of entomological students must be increased.

The growth of a socialist society and the increase in the well-being of its communist citizens involves a broadening of control in public affairs dealing with economic and cultural development. In the resolution which was embodied in Comrad N. S. Khrushchev's report before the XXIst Special Congress of the Communist Party of the Soviet Union there is the clear statement that "many functions, now carried out by the State, must gradually be taken over by public organizations and societies". Undoubtedly, this is an important lead for the scientific organizations. Among such organizations is the All-Union Entomological Society (VEO).

The task of communist development requires an all-around intensification of creative and organizational activities of all sections of the VEO, together with increased propaganda aimed at their popularization. Each section of the VEO, besides being concerned with its own official responsibilities, should be active in organizing popular lectures, in preparing and printing popular brochures, conducting discussions and developing activities within the field of plant protection, the epizootiology of animal diseases and preventative medicine. It is necessary for the Soviet VEO and its affiliated branches in all parts of the country to be active in organizing and inculcating the general ideas regarding defense of crops, and standing timber against predators and its veterinary services doing the same in the field of animal health.

Through the official journal of the All-Union Entomological Society – "The Entomological Review" – we must promote, to a high degree, scientific discussion, and reflect the general trends in progressive research performed by those who are active in the fields of agricultural and medical entomology, as well as stimulating the further development of entomology in the USSR.

ACADEMICIAN EVGENII NIKANOROVICH PAVLOVSKII

(ON HIS 75th BIRTHDAY)

Praesidium of the All-Union Entomoligical Society within the Academy of Sciences, USSR

The 5th of March 1959, is the seventy-fifth birthday of Academician Evgenii Nikanorovich Pavlovskii and the fiftieth anniversary of his advent into scientific work.

It is difficult in a few words to depict the personality of a man of the caliber of E. N. Pavlovskii. A great teacher and scientific organizer, he is, above all, a man of keen human sympathies and great kindness, who has dedicated his knowledge, talents and energy to the well-being of his fellows and of his country.

Of his many and diverse activities it is obviously only possible to stress a few: his enormous output of scientific research carried out in so many different places during his various expeditions; the breadth and caliber of his scientific organizing ability; his many years of teaching and his duties as a public figure.

At the present time E. N. has more than 1000 scientific papers to his credit, covering many aspects of general biology, zoology, entomology, medicine, geographical epidemiology, and the history of natural science.

The numerous parasitological expeditions to Turkmen, Uzbekistan, Tadzhikistan, Kazakhstan, Transcaucasia, the Northern Territories, Crimea, the Leningrad area, the Krasnodarsk district and the Far East, all of which E. N. organized with his characteristic brilliance and indefatigable energy, attracted considerable local interest in scientific research and produced far-reaching results. His personal presence in these projects was a guarantee of their ultimate success. The general trend of E.N.'s scientific work, and that in which he expressed himself most brilliantly, was in the elucidation of problems connected with natural foci of parasitic diseases and the transmission of such diseases; – research which is a lasting contribution to the cause of public health. Especially numerous, and highly original are his researches into the problems of the epidemiology of tick-borne diseases, e.g., recurrent typhus, spotted typhus, together with investigations on seasonal encephalitis, protozoan diseases of man and many other diseases.

E.N. belongs to that select group of zoologists who by virtue of their extensive knowledge and diverse talents have been able to apply their scientific training to a wide range of problems connected with the furtherance of human mastery over parastic diseases of mankind and of animals. The exuberant energy of E.N. has resulted in his tackling problems from all over the vast territory of the USSR, ofter in inaccessible regions where, with the collaboration of local research teams, he as achieved success after prolonged efforts.

During the Great Patriotic War, E. N. carried out extensive expeditions to Iran and Iraq where he made a particular epidemiological study of endemic diseases.

E. N. Pavlovskii has always been a great teacher and has trained innumerable medical parasitologists, research workers and teachers. He has established his reputation, not only as a model administrator of a famous department of general biology and parasitology (the chair of which now bears his name) in the S. M. Kirov Military Academy of Medicine, but also as the author of a great many, widely read University text books, some of which have been translated into foreigh languages, e.g., Polish and Chinese.

He has played a major part in the development of science throughout the USSR.

E.N. was one of the founders of the Tadzhikistan center of the Academy of Sciences, and later its director; furthermore, when the branch was reformed as the Tadzhikistan branch of the Academy of Sciences of the

USSR he was President of its Praesidium. E. N. guided the affairs of the branch right up to the time when it became the Central Branch of the Academy of Sciences of Tadzhikistan SSR of which he was elected an Honorary Life Member. In recognition of his many years of service to the Tadzhikistan Republic, the government nominated him as its deputy to the 2nd, 3rd and 4th Convocations of the Supreme Soviet.

In 1924, E. N. Pavlovskii was nominated (jointly with A. A. Shtakel'berg) to the Perment Commission for the study of malarial mosquitoes at the Zoological Museum, Academy of Sciences USSR, under the Public Health Scheme. This commission did a great work in organizing research on malarial mosquitoes in the territory of the USSR. From its base in the Zoological Institute of the Academy of Sciences, it carried out the organization of research on malarial mosquitoes and other animal carriers of disease. The parasitological section was under the direction of E.N. Pavlovskii.

In 1942, during the diffiuclt period when the Zoological Institute of the Academy of Sciences was evacuated to Tadzhikistan, E.N. was its scientific director. It can be asserted with confidence that E.N.'s taking over the directorship marked the beginning of a new period of development for the Institute. His great erudition, his ex-

ceptional talent for organization, his unique ability in combining theory and practice and his profound tact in exercising authority, together with his great personal charm – all these qualities contributed to his success; moreover, he was able to weld together within the Institute the older generation of specialists who were established authorities and an active school of young research men working for postgraduate qualifications of the Academy of Sciences, who would guarantee the scientific future of the Institute.

The government held E.N.'s work in high regard. "For services to human parasitology", he was awarded the Stalin Prize (1st class); even earlier than this, research which he had undertaken as a member of a team studying encephalitis had been mentioned as being worthy of this same award. E.N. was on 4 occasions decorated with the Order of Lenin, twice decorated with the Order of Red Sciences, twice with the Order of the Workers for Soviet Science, he was also given the Red Star and many medals. E.N. was awarded the Metchnikov Gold Medal and the Great Gold Medal of the Russian Geographical Society.

Under the direction of E.N. the Zoological Institute of the Academy of Sciences became a leading center for Soviet Zoology, where research throughout the whole of the Union was planned and coordinated. During this period also he forged a lasting link with foreign zoologists especially in countries with a peoples'democracy.

E. N. is President of the Geographical Society of the USSR and the Leningrad Parasitological Society. In 1932, he was unanimously elected to the Presidency of the All-Union Entomological Society. He is, in addition, an hononary member of many Soviet and foreign scientific societies.

As we salute E.N. Pavlovskii on the ocassion of the 50th anniversary of his scientific activities, the All-Union Entomological Society within the Academy of Sciences of the USSR remember, especially the great role he has played in the development of Soviet Entomology. His valuable research into many insect groups is a major contribution to science; but this society remembers particularly the part that E. N. has played in using his own personal gifts and reputation to further and extend the influence and popularity of the Society.

Enormous though the measure of E.N.'s scientific attainments may be, he remains a modest and considerate colleague. To many his great personal sympathy and understanding have been a help during difficult periods of their lives.

We hope that this glorious record will spur E.N. on to plan with his usual vigor further projects.

With deep affection and from the botom of our hearts, we wish Evgenii Nikanorovich Pavlovskii good health and happiness for many years to come.

PRINCIPAL TRENDS IN PARASITOLOGICAL RESEARCH IN ARACHNOENTOMOLOGY IN THE USSR *

D. I. Blagoveshchenskii

Many species of insects and arachnids (ticks), found in the fauna of the Soviet Union, are parasitic on vertebrate animals. It is generally recognized that these ticks and insects are harmful, not only as a result of their direct parasitic activities, but indirectly as vectors of diseases. Some of these diseases are common to both human beings and animals, others are peculiar to either human beings or animals. Bloodsucking ticks belonging to the group Ixodoidea have, for example, been estimated as transmitting more than 50 animal diseases of agricultural importance.

The campaign for developing research in veterinary arachnoentomology within the Soviet Union – together, incidentally, with that for medical arachnoentomology– has been largely conditioned by the extensive and profound understanding of bloodsucking parasites of agricultural importance, gained as a result of the research carried out under the direction of E.N. Pavlovskii, by research teams between 1924 and 1934 at the Mobile Laboratory for the study of livestock diseases, in the Novgorod area. This laboratory unit was attached to the veterinary section of the parasitological department within the Leningrad Institute of Applied Zoology and Phytopathology (later the Institute for Agricultural and Forestry Pest Control), a subdivision of the Livestock Pests Section of the All-Union Institute for Plant Protection (VASKhNIL); itself a division (later department) of the parasitological faculty of the Zoological Institute, Academy of Sciences of the USSR. The initial group of co-workers in entomology consisted of the following persons: N. I. Alfeev, D. I. Blagoveshchenskii, N. O. Olenev, N. G. Olsuf'ev, B. L. Pomerantsev and G. V. Serdyukova. At first, research centered around the biology of the tick Ixodes ricinus L. and possible methods of controlling it, as this species is the vector for babesioses of cattle under conditions prevailing within the Novgorod area. Later, the researches were extended to include not merely ixodid ticks but other pests of domestic animals, especially gadflies, warbleflies, lice and flying insects which suck blood.

The above-mentioned researches were carried out as a result of linking together both the taxonomic-faunistic and the biological (in a wide sense) approaches to a study of parasites, utilizing both mobile collecting techniques and field station researches. The complexity of scientific investigation in the field necessitates the cooperation of specialists in many branches of biology and the concentration of their interests toward the solution of the problem on hand. Thus, collaboration between mammologists, ornithologist, herpetologists, entomologists, veterinarians and zoological technicians in required.

The field station method of research provides a means of obtaining information about daily and seasonal changes in the way of life of a particular fauna and of the pests themselves. The mobile collecting method limits the scope of the investigators, but allows the possiblity of obtaining material over a wider area and making more extensive and varied collections. In practice a combination of the two methods is desirable, i.e., the organizing of short-term mobile collecting expeditions from field stations situated at points of particular faunistic, epizootological, epidemiological or agricultural interest and thus, obtaining supplementary material to be used in conjunction with that obtained at the station itself.

*A concise report on the principal trends in the parasitological aspect of arachnoentomological research within the Soviet Union, was given by the author on June 5th, 1958 at the IVth International Conference for Asiatic countries on Parasitic diseases of Animals (p. 105 of the present issue).

Lines of attack against pests of domestic animals, revealed as a result of preliminary work, are now being followed up by veterinarians and medical arachnoentomologists in all the main agricultural regions of the Soviet Union. These approaches may be described as showing the following trends.

First Trend – Faunistic and Biological (sensu latum) Studies of Pests in Relation to the Formulation of Effective Control Measures against Them

This particular trend in research is a dominant one at the present time and has yielded a wealth of material from various agricultural regions of the country. It is based on the general principal that the environment of a particular ectoparasite is worthy of investigation: "For the realization of effective control measures against any particular pest of domestic animals, a complete series of observations and experiments on all its various habitats should be carried out, in order that the key to finding means of combating it may be discovered. The results of observations (especially in the case of parasites living in the wilds and not intimately connected with settled agricultural practice) made at a given point, often can not be applied to other geographical areas, because of the different climatic, vegetational, orographical and hydrological conditions prevailing in different places. The aggregate effect of such conditions may profoundly influence the parasite from both a distributional and adaptational aspect" (E. N. Pavlovskii, D. I. Blagoveshchenskii and L. N. Alfeev). The results obtained by solving such fundamental problems provide the biological basis for their control. Examples illustrating the aforementioned thesis occur in the study of such groups of harmful parasites as ixodid ticks, biting flies, gadflies and parmanent parasites as lice, etc.

Ixodid ticks have considerable importance for veterinary and medical science, the group including many species capable of transmitting diseases of man and domestic animals.

The investigation of faunistic characters, distribution of habitats and life cycles of ticks in nature, together with their seasonal infestation of animals, the duration of their feeding on the host, and the most suitable concentration of acaricidal chemicals to be used against them.—these are practical problems which need to be solved for each locality in which ticks occur. The results of such investigations provide the basis of a system for the effective control of ixodids. Methods of controlling ticks by destroying them while they are on cattle, or while in their natural biotope, together with means of protecting cattle from their attacks, depend on the utilization of chemical and mechanical techniques and appropriate agricultural practices which may be applied simultaneously or independently according to the species of tick concerned and the particular method of animal husbandry prevailing in a given locality (Blagoveshchenskii, 1957).

Biting flies. Those species of Diptera which suck blood may play a locally important part, both as ocassional parasites and as vectors of certain human diseases, in many areas e.g., forest and tundra zones (especially the taiga), in river valleys, around lakes and in other agricultural zones.

The principal lines of research of practical importance relating to biting flies are the determination of species among bloodsucking diptera, estimation of numbers of particular species in a given population, observations on their seasonal and daily rhythms of attacking activity, and the effect of external conditions on this activity. The investigation of which species are present in a particular region and of their biology is of primary importance in regions of new economic development (for example, in timber-felling stations, sites of hydroelectric stations, industrial development sites and where virgin soil is being tilled).

In devising means of combating the attacks of biting flies it is important to remember that their effectiveness depends on the destruction of the feeding places of biting flies in the vicinity of areas of economic development, on the protection of human beings and animals from fly attack both in the fields and in buildings and in the destruction of the flies themselves. Moreover, the working out of combative measures against these pests must be considered in relation to the suitability of their application in different agricultural zones, taking into account the particular productive practices of different systems of cattle rearing and crop raising.

The synthesizing and testing under field conditions of insecticides and insect repellents is of great importance in this connection. Certain protective substances and methods of defense against biting flies have shown themselves to be widely effective in controlling the pests in various agricultural regions throughout the USSR and suggests that their further application will bring about a considerable increase in human labor output and the production of domestic animals.

Oestrid flies. This economically important group of dipterous insects is responsible for cutaneous, intestinal and coelomic myiasis.

Research into the specific composition and host distribution of oestrid flies, into their habitat preferences, the duration of their various developmental stages and the seasonal incidence of attack by their larvae, the duration of the pupal stage, the flight duration of the adults, the time taken by the eggs to hatch and the effect of insecticides upon the adults – all these are important practical lines of research into this group of pests of economic animals.

The utilization of combative means – mechanical, chemical or by agricultural practice – either singly or in combination proves to be most effective if used against vulnerable stages in the life cycle. Practical measures, carried out by veterinary personnel can be highly successful if they are organized on a seasonal basis, especially where considerable areas are involved or in naturally isolated places, where it is possible to impose quarantine regulations and restrictions on the movement of cattle. In planning combative measures it is necessary that all types of agricultural practice must be considered and all possible means of defense; moreover, the demands of animal hygiene must be observed and particular attention paid to the possibility of increasing the resistance of the animal against parasitization.

Permanent ectoparasites. These are often a detrimental factor in animal husbandry.

The main lines of practically important research in connection with permanent ectoparasites are investigation into their specific identity, into the duration of their various developmental phases, into their methods of dispersal and the effectiveness of parasiticidal substances used against them. The destruction of permanent ectoparasites is facilitated by their staying on a single host (the vertebrate) throughout their life cycle. The success of practical methods of control depends on the correct choice of technique and the care with which it is carried out, together with the fulfillment of necessary sanitary and hygiene measures wherever animals are maintained.

Second Trend – A Study of Natural Reservoirs of Transmissable Diseases

This new but already productive trend of investigation sprang from the studies of E. N. Pavlovskii on endemic foci of transmissable disease in natural populations. "A natural reservoir of transmissable disease is a phenomenon resulting from the presence of a causal agency having a specific vector and animal reservoir host, which for a long period of its evolution has had no contact with human beings, but which may transfer itself to the latter". Investigations into this phenomenon have as their ultimate aim the revelation of the links between local endemic diseases of human beings and diseases of both wild and domestic animals, in order that prophylactic measures based on a knowledge of this interrelationship may be worked out.

Investigations into the complexities of these natural endemic foci of diseases have revealed the presence of a rather wide range of reservoir hosts harboring potential pathogens, the former hosts being for the most part wild animals, particularly rodents. The role of ectoparasites as possible vectors for the pathogens has been revealed as a result of ecological and faunistic research into temporary and permanent ectoparasites of such animals. Study of the seasonal dynamics of ectoparasites has acquired considerable importance as an indirect means of determining their probable role in the initial transfer of the pathogen to man. A comparative analysis of curves showing the seasonal incidence of disease and the dynamics of ectoparasites suggests: 1) those ectoparasitic vectors which deserve further investigation with a view of determining their ability to behave as transmitters of the pathogen; 2) the specific epidemiological or epizootiological rolls of different species of ectoparasitic vector and 3) a prognosis of the time of outbreak of such transmissable diseases.

At the present time many transmissable diseases are known to be dependent on natural reservoirs of infection, as for example, tick-borne relapsing-fever and tick-borne seasonal encephalitis. Likewise, the natural reservoirs of a considerable number of diseases peculiar to certain human, animal and plant populations are now known. A study of similar endemic foci of disease in other countries, such as has been carried out in Czechoslovakia and Poland, is a most useful supplement to our work.

Third Trend – A Study of Parasite Coenoses

This new kind of research which is being developed on the basis of "certain theories regarding parasite coenoses and parasitic diseases", was initiated by E. N. Pavlovskii. "The parasite coenosis – this is the aggregate

of all the populations of parasites in the various organs of the host or on the host and consisting of such animal parasites as protozoa, helminths, ticks, insects, together with other parasites such as bacteria, spirochaetes, rickettsias, fungi, considered as a whole irrespective of their pathogenicity" (E. N. Pavlovskii). A study of the parasite coenoses of man and animals reveals a regular occurrence of intraspecific and interspecific interactions between the parasites themselves and also between them and the host organism. This situation makes it possible for the host-parasite relationship to be changed in a manner beneficial to the host by employing rational therapeutic measures. The concept is valuable also as a means of explaining certain peculiarities of disease, for example, latency, "carrier" phenomena and symptomless infections. An infectious or parasitic disease may be considered as the consequence of the interaction between a parasite coenosis and the host organism, under the influence of particular environmental conditions.

Research along these lines is being carried out on the parasite coenoses of fishes, birds and mammals in various parts of the Soviet Union.

Fourth Trend — The Compilation of Taxonomic Works and Monographs Concerning Different Groups of Parasites and Their Hosts

A rational investigation into the biology of ectoparasites (as indeed of all organisms) must be based almost invariably on accurate diagnoses of the species concerned and must take into account their systematic affinities. This demands the availability of works of identification and taxonomic monographs for the different groups of parasites and their hosts (see Literature Cited), as for example those of the "Fauna of the USSR" series and "Identification of the USSR Fauna" series which are published by the Zoological Institute, Academy of Sciences USSR.

Periodical attempts at summarizing and collating information concerning the different groups of parasites and their hosts favors a solution of parasitological problems, generally, and facilitates the planning of further parasitological work.

Such are the four principal trends of parasitological research in veterinary and medical arachnoentomology. The faunistic composition and life cycle of ectoparasites depend on distinctive factors which operate in nature and on the host in the various places where the parasites occur. Hence, the contents of the research which has been described are derived from different agricultural zones and such widely based research has led to the solution of cardinal problems in parasitology – problems of agricultural parasitology common to all parts of the USSR although each part may have its characteristic epizootic diseases. In the case of temporary parasites there has been an intensification of research into what might be termined their agricultural ecology, i.e., the practical investigation of biotopes from the point of view of their suitability or otherwise, on a basis of their floristic or faunistic composition for the parasites concerned.

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*In Russian.

THE LIFE FORMS OF INSECTS INHABITING THE NARYN SANDS OF THE SEMIDESERT TRANSVOLGA REGION

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As a number of the Sands Division of the Forestry Institute AN SSSR (Director: A. G. Gael') the author of the present paper, during 1952-1954, studied the formation of the insect fauna of tree plantings on the Naryn Sands. In tackling this problem it was essential to demonstrate not only what forms live in these tree plantings, whence and how they got there, but also what forms dwell in the neighborhood of forest, how they are characterized, and whether they seek forest or avoid forest conditions. In connection with these problems a more general question required an answer: how are the forest biogeocoenoses and other surrounding biogeocoenoses in the Naryn Sands characterized and what are their interrelationships?

The scope of the article does not permit a detailed description of the relief of the Naryn Sands, its origin, development and dissection, nor a zoogeographical characterization of the insect fauna of this range; I can only give a brief summary of this.

The Naryn Sands or Ryn Sands is the name given to the northwest region of the Volga-Ural sand massif, which extends into the semidesert zone. They consist of ribbon-shaped sand ridges (the Kazakh word "naryn" means ribbon), divided by depressions ("ashiks").

The Naryn sand ridges and the channel-shaped depressions between them represent a complex of deltaic alluvial deposits formed by the repeated shifts of ancient rivers. This process came to an end after the Khvalynsk transgression, about 5-6 thousand B.C. The relief was strengthened by the subsequent growth of grasses, shrubs and trees on the sand hills.

The vegetation which arrived during the "Atlantic" climatic period (5-6 thousand years B.C) from the steppe zone, and even from the forest zone (willow, poplar, black alder), and later from the desert zone in the period of the maximal Caspian regression (2-4 thousand years B.C.), was accompanied by the insects which lived on these plants. The introduction of pine, black locust and certain other trees, which began in the late 19th century, led to the introduction of insects specific to them.

At the present time three types of biogeocoenoses are found in the Naryn Sands: 1) in the naryns – hills of bare, loose sand with scattered clumps of psammophytes; 2) on the ashiks – dense grass on well-developed sandy soil (more of a steppe or meadow type); as a variant of this type, the grass cover may be supplemented with trees and shrubs; 3) in the hollows between the sand-hills – forest.

A determination of the groupings characteristic of these types of biogeocoenoses should reveal the ecological distribution of the insects, while the complex of these groupings should give an entomogeographical characterization of the Naryn Sands. The author of this work did not carry out systematic quantitative surveys, which would have made it possible to compare the abundance, or to ascertain the absence, of certain species in each particular biotope. My collections only enable me to confirm the definite presence of a species in a particular biotope. The recognition of a species as a dominant or indicator ("endemic") species may largely be determined by subjective impressions; we note that Kamenskii [1949] considered this permissible. We must also point out here that this author very firmly established the relationship between insect groupings and plant associations. The aim of the present paper is to demonstrate the relationships of insects with particular biotopes, and thus to reveal the endemics.

Among the insects in the three named types of biogeocoenoses we can find representatives of the desert, semidesert, steppe, forest-steepe and forest zones. Theoretically, these insects should be distributed in the following way: autochthonous elements, i.e., specific representatives of this geographical landscape zone, inhabit typical zonal habitats; allochthonous elements should occupy intrazonal biotopes which most resemble the typical landscapes from which the species came. In very many cases the distribution is like this. In particular, the majority of dendrophiles, as also in Naurzum [Kamenskii, 1949], are representatives of the forest and forest-steep zones. The zoogeographically characteristic species are stenotopic, localized in habitat, as both Kamenskii [1949] and Stebaev [1957] noted; examples of these zoogeographically characteristic species are given below, in the characterization of life forms.

The semidesert is characterized by alternating regions, typical either of steppe, or of desert. On the Ryn Sands, besides the desert and steppe biogeocoenoses, true forest biogeocoenoses have also developed. How typical these regions are for one zone or another is determined mainly by the degree of similarity of soil and plant cover; besides this, the situation north of the desert zone and south of the steppe zone introduces a specific zonal factor – the influence of a semidesert climate, intermediate between that of steep and desert. The hypothesis that climate is of great significance in the formation of the semidesert fauna is very well-grounded.

It is obvious that information on the occurrence of a particular species on ashiks ("steppe"), sands ("desert") or in tree plantings ("forest"), on its zoogeographical origin and on the extent to which it is xero-, meso- or hygrophilous is still not adequate to determine its life form. It is necessary to characterize the interrelationships of the insects with the other constituents of the biogeocoenosis.

Of the links determining the relation of the animal organism to its environment the food link must be considered foremost, since it, in fact, maintains the existence of the organism in any environment and introduces it to new conditions; as an example, we might take the introduction of particular plants with their specific complex of insects dependent on them.

Ter-Minasyan [1944] and other authors have shown that the spread of insects and their distribution within their range are determined in the vast majority of cases by their historic connections with particular landscapes through their food plants.

Transference into a zone with a different climate quite often leads to a change of habitat, and the same rule frequently holds for the food organism also (in the case of phytophages – the plants, in the case of entomophages – their insect prey).

In his account of the geographical distribution of the Pieridae, Kuznetsov [1930] showed their relationship with the chemism of the food plants, this relationship being determined by the adaptation of the alimentary (gustatory and olfactory) instincts of these insects.

Next in importance comes the degree of adaptation to the microclimate of the environment. The distance of the boundaries of a range from its center depends on the ability of the organism (when food is present) to tolerate changes in the required amounts of heat, light, moisture and other climate environmental factors, which as a whole determine the steno-or eurybiontic nature of the species. In the adaptation of a species to microclimatic conditions, we also find the rule of change of habitat according to the zone [Bei-Bienko, 1930]. Very many authors explain the occurrence of animals in one biotope or another according to the extent to which they are xero-, meso- or hygrophilous. This basis would appear to leave out the question of food links and give priority to such properties as affinity for light, heat or moisture. The question of the presence of food is very easily overlooked when polyphagous species are being considered.

In very rare, one might say exceptional, cases an insect is deprived of its normal food plants and adapts itself to feeding on others. In such exceptional cases, the food relationships of the organism would appear to take second place (since suitable microclimatic conditions are available); however, food relationships do not lose their decisive significance, since a failure to establish them would, of course, lead to the death of the organism and its disappearance from the particular locality, despite the suitability of the microclimate.

Medvedev [1954] cites examples of thermo-, photo-, or umbraphilic forms, which are either polyphagous or are associated with such forms of food plants.

Sometimes the choice of habitat in a particular locality, i.e., the ecological valency of the species, is

governed by some one factor, or a few factors, of the environment rather than their sum. If we take the three basic relationships with the environment – the food, the biotope and the stratum from which the food is obtained – the decisive relationship will be the one which is most restricted. In fact, in extending its range, a monophage follows the food plant as far as temperature or moisture allows. Shteinberg [1952] cites an example of insects in the flood-plain of the R. Ural, which do not extend to the boundaries of the range of their food plants. A polyphage, by changing its food, tends to remain in optimal conditions of temperature and moisture. For instance, Belyaeva [1955] tells us about semidesert beetles which in extreme conditions of existence are able to change over to food which is unusual for them. Species which possess a wide scale in all these relationships are able to expand their range to the greatest extent by inhabiting a diversity of biotopes. For instance, the pine "brought" the pine-shoot beetle Blastophagus piniperda L. into the semidesert Naryn Sands, and here, by sticking to its food plant and remaining a mesophile, it "descended" to the root branches in conditions of severe drought;* the pyralid Etiella zinckenella Tr. has colonized pea tree and black locust, besides leguminous plants of the grass cover on treeless areas, and has occupied the forest mesophtyic biotopes in addition to the steppe xerophytic biotopes. Shaposhnikov [1953] reports that the aphids dwelling on poplar, Thecabius affinis Kalt. and Pemphigus bursarius L., have extended further north than the poplar, the first by transferring to buttercup, the second by transferring to lettuce and sow-thistle.

In substantiating the inclusion of any animal in a particular biogeocoenosis, i.e., its adaptation to the specific conditions of the latter, we must determine the life form of the animal. The determining features of the life form must be first, the trophic relationships – the type of feeding and the place of obtaining food, and secondly – the preferred conditions of temperature and moisture.

My classification of life forms is based on the type of feeding and the stratum (level) from which food is obtained. A classification of life forms by such characters was suggested by Formozov [1950, 1956] and is the most logical, since it is erected on the fundamental relationships of the animal with its environment. We must not forget that an investigation of the food relationships, as of the ecological category, also reveals the economic significance of the animals.

Of course, trophic relationships do not constitute the whole concept of life forms. However, since the type of metabolism and the nature of its regulation are fundamental to an ecological characterization, we should be quite correct in assuming that feeding peculiarities form the basic grouping.

The relegation of a species to any stratum of habitation is not made on the basis of the place where the longest time is spent, but according to the mode of obtaining food. For instance, the ground beetles (Scarites), which spend the greater part of the day in burrows and come out on to the soil surface to hunt when darkness falls, must be classed as herpetobionts, and not as geobionts. This approach to the problem led to the separation of a group of aerobionts [Dogel', 1921], i.e., insects which obtain their food in flight. Hence, the designation "dweller" ("biont") of a particular environment in the discussion below must be understood to mean an animal obtaining food in that environment; it would be hardly advisable to replace this well-established term because of its lack of exactness.

It should be stressed that in characterizing the feeding of the majority of insects I considered the basic food as that which it consumed in the larval phase, and not in the imaginal phase. Hence, many cerambycid beetles are assigned not to pollen-eaters, but to xylophages, and many lepidopterans are classed not as nectar-feeders, but as leaf pests. An exception is made in the case of robber flies, in which the feeding in the adult phase is of very great importance.

Very many species are associated with their food only in the larval phase, but they usually pupate in the same biotope, and the adult insects usually remain there too, thus ensuring that food is available for their progeny. However, we do know of forms, robber flies for instance, in which the adults have much more extensive habitats than the larvae; sand wasps, which fly over flowering plants on the ashiks, rear their larvae in holes on open sands. Nevertheless, these are exceptions, and the majority of species are characteristic of the biotopes where their larvae feed.

*This is a case of "microhabitat localization" which, according to Stebaev [1957], satisfies the demands of the species and the conditions of a local environment which in general is uncongenial to the given species.

The above considerations enable us to establish the life form of parasitic insects. Since their main feeding takes place in the larval phase when attached to the host's body (inside or on its surface), the habitats (strata, levels) of the latter will be habitats (strata, levels) of the parasite. I should emphasize that I use habitat* here in the relatively wide sense of the word ("ground", "soil surface","within the grass cover", etc.) and not in the narrow sense (for instance, "ball of dung buried in soil" or "hole in sand"); hence, there is no basis for designating the host's as the habitat of the parasite. In view of the fact that in the present work we consider only parasites of insects they are classed as entomophages.

Incidental occurrence in some strata or special conditions was the basis for the establishment of such subgroups, as bothrioxenes; these visitors to burrows must be classed as dwellers of that stratum where they regularly obtain their food.

On the basis of the above considerations we have compiled the given Table, in which examples of life forms for each food stratum are arranged in vertical columns. The tendency for forms to seek particular conditions of temperature and moisture, denoted by the suffix "phile" is shown in the horizontal rows. It must be pointed out that the species cited as examples are arranged in the ecological groupings of this Table in accordance with their behavior in the Naryn Sands, and not according to their general characteristics throughout their whole range. In other words, the life form of a particular species decides the nature of its population (in the sense of Gilyarov [1954]) in local types of biocoenoses.

The list of examples in the Table far from exhausts the whole diversity of the insect fauna of the Naryn Sands, many representatives of which I did not record. The examples are taken mainly from the Orthoptera, Hemiptera, Coleoptera, Hymenoptera and Diptera; the Homoptera and Lepidoptera received much less study and the other orders were hardly touched at all.

We will examine the characteristic features of each group.

Dwellers in the soil – geobionts–either actively obtain their food in the soil or they consume food which is stored up for them by individuals which go out on to the surface. According to the nature of their food they may be classed as phyto-, entomo-, copro- and saprophages. The vast majority of geobionts dwell in the soil in the egg, larval and pupal phases, while the adult insects leave the soil; they are classed as geobionts, since their main feeding takes place in the larval phase.

Those which actively seek their food can be divided into the following subgroups:

a) feeders on roots (and other underground parts of plants) – rhizophages; larvae of cockchafers, click beetles, darkling beetles, soil-dwelling noctuid caterpillars, etc.;

b) predators feeding on other geobionts – free-living entomophages: larvae of Scarites, Cardiophorus, etc.;

c) feeders on detritus and other decomposing organic matter – saprophages.

To the geobiont-saprophages we should assign the bothrioxenes, i.e., commensals, which visit rodent burrows; yet, we must not classify, in this way, those bothrioxenes which usually feed in other strata, and not in the soil.

Those which feed on stored food, i.e., which do not seek it actively, and which may be called hole-dwellers, are divided into the following subgroups:

d) consumers of plant food – phytophages, for instance bees which nest underground;

*The words "habitat" and "microhabitat" have rather different connotations. This first term implies the kind of territory inhabited by a species or individuals of a species, but does not lay stress on the particular location within the territory. The second term denotes the particular location or spot where the animal lives. We consider that both terms are permissible. If we remove the implication of an "actual spot" from the concept of "habitat", then the term "microhabitat must be introduced to connote "the place where the species actually lives", for example, the habitat of the rusty pine-sawfly is pine-forest, whereas its microhabitat consists of the branches and foliage of pine trees.

e) those feeding on insects – entomophages; for some of these the parents lay in a store of food (for instance, digger wasps), others are parasitic in the underground nests of Hymenoptera and feed on the food prepared for others, and some feed on the egg-batches of locusts, and so on;

f) those feeding on excrement stored in an underground nest – coprophages.

Dwellers on the soil surface – herpetobionts – I have divided into dwellers of open (including shore) areas and dwellers on a surface covered with vegetation, leaves, and plant remains. Here, we find the forms designated by Bei-Bienko and Mishchenko as open geophiles and herpetobionts. If we adhere strictly to the principle of naming as dwellers of a level (stratum) those forms which obtain their food in that level (stratum), then as herpetobionts we must class insects which feed either without climbing on to plants, or which climb on to them only occasionally and for short periods.

The following subgroups may be noted:

a) those dwelling on open (with sparse plant cover) localities on sand or the banks of ponds and mud deposits and feeding on the vegetation – exposed herpetobiont-phytophages;

b) those dwelling in similar circumstances, but which are predaceous – exposed herpetobiont-entomophages;

c) plant-eating insects living concealed (under grass cover or under woodland litter) – concealed herpetobiont-phytophages, including "hole-dwellers" which come out to feed on the surface, crickets for instance.

d) predators living in similar circumstances (concealed) – concealed herpetobiont-entomophages, for instance certain carabids; here, too, we include "hole-dwellers", which hunt on the surface, for instance mole crickets, antlion larvae, etc.;

e) those living concealed (usually in a food substrate) and consuming decomposing organic matter – concealed herpetobiont-saprophages;

f) excrement-feeders living in similar circumstances – concealed herpetobiont-coprophages.

Dwellers in the grass cover – hortobionts – are divided only according to the nature of their feeding into phyto- and entomophages, since the observations and materials of the author did not provide any basis for separating them according to the stratum of the grass cover.

Dwellers in the aerial parts of trees and bushes – dendrobionts. The true dendrobionts and thamnobionts [Bei-Bienko and Mishchenko, 1951] were united into one group because it was impossible to find objective differences between trees and bushes as habitats. Branching from the root neck in bushes or the formation of a crown at a certain height on the trunk in trees is of significance from the viewpoint, for instance, of the accessibility of the branches for jumping locusts, but are of practically no importance for the flying insects. The pests of any woody plant, as far as I know, do not change as a result of its change from the bush to the tree form; in particular, I did not observe differences in the oleaster and poplar, which exist in both forms in the Naryn Sands. Dwellers on the underground parts of trees are assigned to the geobiont group.

Dendrobiont-phytophages normally live directly on the food substrate or even within it. We can distinguish insects which feed on the organs of assimilation (leaves, buds, shoots) and which dwell on them or in them; insects which gnaw the leaves or needles, sucking and mining insects, and those which damage the leaves by other methods, may be called phyllobiont-phyllophages. Those which feed on the reproductive organs – flowers and fruits – and dwell in them, can be called carpobiont-carpophages. Insects which bore through the bark, cambium, sapwood and deeper layers of wood in trunks and branches can be called xylobiont-xylophages.

The dendrobiont-entomophage, as a rule, follows its prey. For instance, Calosoma sycophanta L. lives in association with gypsy moth caterpillars, ladybirds in company with aphids, and so on. Parasites, which live either in or on the body of their hosts, are even more closely associated with their victims.

Water dwellers – hydrobionts – are very scarce in the Naryn Sands; they live in the water or salt lakes and in mud beds, as well as in wells. Here we can distinguish:

a) hydrobiont-phytophages (more exactly, algophages) and b) hydrobiont-entomophages.

TABLE 1

Examples of Life Forms in the Insect Fauna of the Naryn Sands

Groups of life forms / Ecological grouping	Dwellers in soil – geobionts	Dwellers on the soil surface (including litter-dwellers) – herpetobionts
Desert xerophiles	*Anomala errans* F. *Scarites bucida* Pall.	*Hyalorrhipis clausi* (Kitt.).
Semidesert xerophiles	*Polyphylla alba* Pall. *Aphodius aequalis* A. Schm. *Ceratophyus polyceros* Pall. *Chioneosoma pulvereum* Knoch. *Potosia karelini* Zubk. *Byrsinus fossor* (M. R.). *Blissus putoni* Jak.	
Steppe xerophiles	*Legnotus picipes* (Fall.). *Aphodius sulcatus* F. *A. punctipennis* Er. *Gymnopleurus mopsus* Pall. *Gonocephalum pusillum* F.	*Cicindela atrata* Pall. *Harpalus calathoides* Motsch. *Calosoma denticolle* Gebl.
Eurybiontic xerophiles	*Scarabaeus sacer* L. *Anoxia pilosa* F. *Epicometis hirta* Poda *Pimelia subglobosa* Pall. *Nomia diversipes* Latr.	*Harpalus fuscipalpis* Sturm. *Cleonus piger* Scop.
Weakly mesophile steppe forms	*Crypticus quisquilius* L.	*Sciocoris cursitans* (F.).
Steppe mesophiles (typical)	*Anisoplia segetum zoubkovi* Kryn. *Cardiophorus rufipes* Goeze.	
Meadow mesophiles	*Agriotes lineatus* L.	*Gryllulus desertus* (Pall.).

Dwellers in the grass cover – hortobionts	Dwellers in the aerial parts of trees and bushes – dendrobionts	Water dwellers – hydrobionts	Those obtaining food in the air – aerobionts
Ochrilidia hebetata kazaka (Tarb.).	—	—	*Satanas gigas* Eversm. *Polysarca ungulata* Pall. *Apoclea helvipes* Loew.
Sphenoptera exarata Fisch. *Agrilus sericans* Kiesw. *Phimodera distincta* Jak.	—	—	—
Calliptamus italicus italicus (L.). *C. barbarus barbarus* (Costa). *Chorosoma schillingi* (Schill.). *Ptochus porcellus* Boh. *Cataglyphis cursor aenescens* Nyl. *Ulochlena hirta* Hb.	*Chaninthus pannonicus* Germ.	—	*Leptogaster cylindrica* Deg. *Echthistus rufinervis* Wied.
Dociostaurus brevicollis (Ev.). *Zicrona coerulea* (L.). *Carpocoris fuscispinus* (Boh.). *Dolycoris baccarum* (L.). *Formica rufibarbis* F.	*Bulaea lichatschovi* Humm.	—	—
Adelphocoris lineolatus Goeze. *Eurydema festiva* (L.) *Eurygaster integriceps* Put.	—	—	—
Decticus verrucivorus L. *Pararcyptera microptera microptera* F.-W. *Dicranomerus agilis* (Scop.). *Malacosoma castrensis* L.	—	—	—
Tettigonia viridissima L. *Chorthippus albomarginatus* (Hv.). *Aiolopus thalassinus* (Fabr.).	*Lepyronia coleoptrata* L.	—	—

Continued

Groups of life forms / Ecological grouping	Dwellers in soil – geobionts	Dwellers on the soil surface (including litter-dwellers) – herpetobionts
Woodland mesophiles	—	—
Eurybiontic mesophiles	*Lasiopsis caninus* Zoubk.	—
Hygrophiles (including halophiles)	—	*Sphingonotus salinus* (Pall.). *Saldula pallipes* (F.). *Cicindela elegans* F.-W. *Scarites terricola* Bon. *Dyschirius* sp. *Leucomigus candidatus* Pall. *Eristalis arbustorum* L. *Ophyra anthrax* Meig.
Eurybionts	*Aphodius melanostictus* W. Schm. *A. granarius* L.	—
Hydrophiles	—	—

Dwellers in the grass cover – hortobionts	Dwellers in the aerial parts of trees and bushes – dendrobionts	Water dwellers – hydrobionts	Those obtaining food in the air – aerobionts
Synharmonia conglobata L. *Synthomis phaegea* L. *Gonopteryx rhamni* L.	*Calosoma sycophanta* L. *Phaenops cyanea* F. *Criocephalus rusticus* L. *Rhynchaenus alni* Müll. *Blastophagus piniperda* L. *Paururus juvencus* L. *Neodiprion sertifer* Geoffr. *Fenusa dohrni* Tischnb. *Croesus septentrionalis* L. *Lophyroplectus luteator* Thunb. *Euproctis chrysorrhoea* L. *Ocneria dispar* L.	—	—
Chrysomela marginata L. *Athalia colibri* Christ. *Plusia* (*Phytometra*) *gamma* L. *Apanteles lacteus* (Nees). *Etiella zinckenella* Tr.	*Apanteles lacteus* (Nees.). *Etiella zinckenella* Tr.	—	—
Heterocerus parallelus Gebl. *Hippodamia tredecim-punctata* L.	—	—	—
Pyrrhocoris apterus L. *Corizus hyosciami* L. *Lygus pratensis* L. *Coccinella septempuncta-ta* L. *Adonia variegata* Goeze. *Gastroidea polygoni* L.	—	—	—
—	—	*Cymatia rogenho-feri* Fieb. *Sigara* sp. sp. *Gerris lacustris* L. *Cybister laterimar-ginalis* De Geer. *Hydrous piceus* L.	—

Those obtaining food in the air – aerobionts–of course, are all entomophages; they are represented primarily by the robber flies, which are very numerous on the Ryn Sands.

Depending on the ecological valency of the species, its habitat may be either characteristic biotopes, or only parts of them, or whole groups of biotopes; this decides the steno- or eurybiontic nature of the species.

On examining the nature of the distribution of certain ecological forms of insects in various geographical landscape zones of the Ukraine, Medvedev [1954] proceeded from the indisputable postion of the role of moisture (acting in combination with temperature) as one of the most important environmental factors. This factor influences both the spread of insects into different climatic zones and their distribution according to the relief. On the Ryn Sands, where the precipitation is very slight and the water table on the hills and basins is subject to very considerable variations of level, this factor is of immense significance. In the cited work Medvedev gave a very thorough definition of xero-, meso- and hygrophilism as different degrees of adaptation to life in certain conditions of moisture relative to temperature conditions and classified insects into corresponding groups. This grouping was adopted for our Table. In regard to a few insects, we can note a zonal change of habitat, which is seen when we compare the results from the Naryn Sands and the Ukraine. In this connection, we should bear in mind Arnol'di's [1952] assertion that an insect can be characterized accurately only in the field, since in the north it may behave as a xerophile, and in the south like a mesophile.

The desert xerophiles belong to zonal biotopes, i.e., they prefer sands with a minimum of plant cover. To this group, Medvedev [1954] assigned the white (Polyphylla alba) and mealy (Chinoeosoma pulvereum) chafers. The white chafer, found in the steppe zone of the Ukraine in the sparsely covered sands of the upper river terraces, develops in the Naryn Sands in meadow soils on the ashiks, in poplar groves, where it also flies; the mealy chafer develops here in the sands, but also flies on the ashiks. It follows from this that these two chafers behave as semidesert xerophiles, and not as desert xerophiles. This can be explained by their origin and the rule of the zonal change of habitat: they both (semidesert in origin) are more xerophilic in the steppe than in the semidesert.

Semidesert xerophiles belong to the more overgrown sands, and also colonize certain parts of the ashiks (low sand hills transitional to the naryns, solonetz soils and other steppe regions tending to become xerophytic). The representatives of the semidesert zone (see Table) and certain other species behave like semidesert xerophiles both in the Naryn Sands, and in the Ukraine. Potosia karelini Zubk. (a desert-dweller) dwells here on the ashiks, while others (the steppe-dwellers Aphodius aequalis A. Schm., Agrilus sericans Kiesw., Ceratophyus polyceros Pall. and the desert-dweller Sphenoptera exarata Fisch.) inhabit the sands. It would appear that the choice of habitat here is governed not so much by origin and the temperature relationships (the semidesert is a transitional zone both for steppe and desert) as by the action of other environmental factors [Medvedev, 1954]. For instance, for its development Potosia selects soils with an adequate content of plant remains, and for its supplementary feeding an adequate amount of flowering plants; the two buprestids follow their food plants (Artemisia and Chondrilla, respectively), while the two dung beetles are found on sands, apparently as a consequence of their being highly stenobiontic in respect to substrate (psammophiles), and less so in regard to temperature and moisture conditions.

Steppe xerophiles are typical of the ashik steppe portions, which are covered by grass – varied-herbage associations with Siberian wheat grass (Agropyrum sibiricum) predominating; some of them invade the sands but keep either to the margins of the ashiks, or to the low-lying areas (basins). Many of the species of this group coincide with the Ukrainian species; of these, only one representative of the desert zone, Calliptamus barbarus barbarus (Costa), remains in the sands without encroaching on to the ashiks. Since steppe, semidesert and desert biotopes serve as their habitats in the Ukraine, the coincidence of the groups requires no explanation.

Eurybiontic xerophiles, capable of tolerating large fluctuations in moisture in the heat of the day, inhabit several biotopes in the Naryn Sands. This eurybiontism endows species of this group not only with a local eurytopy, but with extensive ranges, and hence it is understandable that several species listed in this line of the Table occur both in the Ryn Sands and in the Ukraine.

Weakly mesophile steppe forms, more or less thermophilic and very close to steppe xerophiles, also colonize the steppe portions of the ashiks, but are rarely found in the sands.

Steppe mesophiles (typical) do not extend outside the ashiks, but some of them inhabit the grass cover in woods. The recorded extension of certain of these beyond the limits of the relatively mesophytic biotopes

can be explained either by their food relationships [for instance, Anisoplia segetum zoubkovi on wild rye (Elymus) on the sands] or by the small area and close proximity of different biotopes (for instance, woodland and bare sand).

Meadow mesophiles belong to meadow (more mesophytic) biotopes on the ashiks and to the grass cover in woods. This group is, of course, small in number in the Naryn Sands.

Forest mesophiles in the Naryn Sands cannot be divided into central and outskirt forms, since the area of the woods does not exceed 0.5 ha, and wood outskirts are absent in the most cases. *

The group of forest mesophiles in the Naryn Sands include the pests of pine alder, black locusts, etc., i.e., those trees which are found only in the plantations here, and certain other insects. Of course, the majority of them are immigrants from the forest zone. The group of forest mesophiles embraces not only those forms living deep in the wood, but also those which in the Ukraine belong to the outskirts and are universal; here the rule of zonal change of habitat is operative. A smilar phenomenon was observed also in the Ukarine [Medvedev, 1953]; those species which live in the forest zone both in the woods and in open spaces, dwell exclusively under the tree cover in the steppe.

Eurybiontic mesophiles, capable of living in a wide range of moisture conditions, are found in the Ryn Sands on the ashiks and in the groves of trees, but do not extend into the sandy biotopes.

Hygrophiles are represented only by forms living near water and are concentrated on the damp solonchak soils near the mud beds of Khaki and on the shores of ponds.

Eurybionts are represented in the Ryn Sands by a few species; this group is numerous in the Ukraine, of course, since there the contrasts between the xerophytic conditions of the deserts and the mesophytic meadow and forest biotopes are apparently sharper.

Hydrophiles dwell in the water of salt muds and ponds, or in wells.

We will attempt to formulate some conclusions. The complexity of the insect fauna of the Naryn Sands is due to its being composed, on the one hand, from a small number of autochthonous forms of the semidesert zone, and on the other, from a large number of representatives of the adjacent (desert and steppe) and even remote (forest-steppe and forest) zones, which penetrated into this area when these zones altered their boundaries at different periods of the Caspian regression. The distribution of different species among the biotopes is governed by trophic relationships and by the degree of adaptation to different conditions of temperature and moisture. These ecological characters were established during the development of the life form and in the case of immigrants could have been subjected to certain modifications in the process of adaptation to local conditions. Hence, certain species, particularly the zoogeographically characteristic species, are more localized, while others are eurytopic. Forms which are semidesert in origin or by adaptation, may be specific to biotopes of the desert or steppe type, but their zonality is determined by their degree of adaptation to the semidesert climate. In this case the food relationsips are the most conservative, while the relation to ecoclimatic factors is more subject to modification.

SUMMARY

The ridges of the Naryn Sands consist of the alluvium of ancient deltas which was laid down on top of clay beds after the Caspian transgression (6-5 thousand years B.C.). At that time there extended over this region the vegetation not only of the steppe zone, but of the forest zone also. During the period of maximum regression

*Medvedev [1954] pointed out that a group of forest xerophiles might be distinguished, in saxual thickets for instance. In the desert (sandy) biotopes of the Naryn Sands the saxaul thickets are like the groves of other trees or bushes, and grow on the tops and slopes of the sand hills; in the prevailing conditions of intense heat and inadequate moisture (the rain water rapidly sinks deep into the sand, leaving the upper layers dry, and on the hills the capillary-water zone is found at a depth of 3-7 m or more) these groves of poplars, willows and Calligonum provide a certain amount of shade and protection from the wind. Yet in view of the poverty of the tree stand in these groves this protection from the sun and wind does not differ much from that provided by solitary trees. Hence, forest conditions do not operate here, and I have not distinguished a group of forest xerophiles in the Ryn Sands since I did not find any signs of gravitation into forest among dwellers on the trees and bushes on the sands.

(4-2 thousand years B. C.) the vegetation of the desert zone encroached into this area from the southeast; the steppe formations then receded toward the north, but a few elements of the forest vegetation (willow, poplar, black alder) remained in the hollows between the sand hills and others (Oleaster) in the plains between the sand ridges.

The insects were present with their food plants and together they adapted themselves to the new environment and to the climatic conditions of the semidesert.

In the nineteenth century planting of pines, locust trees (Robinia) and a few indigenous species of trees was begun and by the present time true forests with specific insects have been created in the sand hollows.

In this paper the life forms are classified in their habitats by two characteristics: 1) the level (stratum) from which the species obtains its foods; 2) their striving for certain moisture and temperature conditions, which is determined mainly by the origin of the species (see Table 1). Besides their specific habitats, life forms are classified according to their feeding: plant-eaters, those which prey on other insects, those which feed on rotting organic matter, and so on. The feeding characteristic is given for the larval stages except in the case of the robber flies, where the feeding of the adults is of great importance.

The method adopted enables us to characterize each species by no less than three features. For instance, the carabid Scarites bucida Pall. is a desert xerophile species, a soil-dweller and a predator; the cerambycid Criocephalus rusticus L. is a forest mesophile species, a tree dweller and a wood eater.

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HEMOLYMPH AND ITS FUNCTIONS IN BLACK FLIES (DIPTERA, SIMULIIDAE)

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The present work is a continuation of work published earlier (Rubtsov, 1956a) which dealt with the gonadotrophic cycle and the need for bloodsucking in black flies.

It is not by chance that the fat body and cellular elements of the hemolymph are called the internal environment of the insect organism: being so defined it is as if it was contrasted with the external medium with its various influences and reactions which comprise the sum total of conditions of existence. The fat body and cellular elements of the hemolymph perform very diverse functions. In the first place the functions of metabolism, assimilation and dissimilation of food substances are accomplished principally by this polymorphic and polyfunctional tissue. Again, the accumulation, continuous storage, the transformation and transportation of reserve food substances consumed in the processes of growth, development and metamorphosis, in short, the whole of the intermediate metabolism, is accomplished mainly with the assistance of the fat body and formed elements of the hemolymph. Furthermore, the functions of excretion and secretion are ascribed to these tissues and this is true for black flies as our observations have shown. Finally, the fat body and cellular elements of the hemolymph carry out protective functions in the organism and form a link between the individual tissues.

Hence, it is obvious that the cardinal importance of these tissues in ontogenesis, in behavior and particularly in the development of the adult insect was correctly visualized long ago. A knowledge of the state of the fat body enables one to form an opinion on the extent of development of a given individual, in particular, on the completion of development of the sexual products and also on the behavior of the female toward bloodsucking. Rubtsov (1956a) showed that the intensity of attack by bloodsuckers is primarily determined by deficiencies in accumulation of food reserves or by their exhaustion and the resultant necessity for supplementary feeding.

The many functions performed by the fat body and cellular elements of the hemolymph and their changes during the processes of growth and development of the insect account for the unusual diversity of this tissue. It is unique in each species and uncommonly variable during ontogenesis, both quantitatively and qualitatively.

The literature dealing with the fat body and cellular elements of the hemolymph is, on the whole, very comprehensive. In the first place, from our own literature, there are the classical researches of Pospelov (1910) on the postembryonic development and imaginal diapause of lepidoptera. Then, among the most recent articles must be mentioned the work of Larchenko (1956), who has compiled a bibliography on the question on which we cannot pause here.

There is a still more complete foreign literature on the subject. The information obtained since 1938 is brought together in the reliable summary by Pardi (1939). In it are upwards of 350 works devoted chiefly to the fat body or to questions connected with it. At the same time this literature is poor and inadequate where individual groups of insects are concerned. Information of the hemolymph, fat body and cellular elements of black flies is almost absent. It amounts to fragmentary data (Epure, 1937; Scriban and Dragut, 1953). We mentioned a few in the second issue of "The Fauna of USSR" (Rubtsov, 1956b) and also in the individual papers (Rubtsov, 1955, 1956a, 1956b). Inquiries on the morphology, development and functional importance of the

fat body and cellular elements of the hemolymph in black flies await investigations. While making an attempt in the present work briefly to throw light on a few of these questions we, moreover, do not aspire to illuminate the problem as a whole and the voluminous literature on the question will be mentioned only so far as is necessary in connection with the examination of actual data for black flies.

MATERIALS AND METHODS

Larvae, pupae and imagos of the following species were used: Prosimulium alpestre Dor. and Rubz. and Gnephia lapponica End. as obligatory, phytophagous species; Eusimulium latipes Mg., E. bicorne (Dor and Rubz.), E. aureum Fries, Schonbaueria pusilla Fires., Wilhelmia equina L., Boophthora erythrocephala De Geer., Gnus relictum Rubz., Odagmia frigida Rubz., Simulium morsitans Edw., S. paramorsitans Rubz., S. austeni Edw., S. galeratum Edw. as facultative bloodsuckers; lastly, Gnus cholodkovskii Rubz., Odagmia ornata Mg., Simulium argyreatum Mg. as representatives of the obligatory bloodsuckers.

Observations were made on freshly caught insects and on material dissected in the laboratory. Dissection was carried out in Efrusi liquid. Cells were examined either in vivo without staining or were often stained with vital stains: trypan blue, neutral red, Janus green, methylene blue. Other stains were tested (methyl violet, azure II, isamine glue). The best results were obtained with neutral red and trypan blue. Neutral red gave a range of tints from crimson to straw color which revealed differences in the pH of protoplasm and cell inclusions. Trypan blue was very good for showing up basophil elements and accumulations in secretory cells. For observations on fat, we used Sudan III. From one individual we usually made 2-3 preparations which were dyed in various vital stains.

In 1955, we used the biuret reaction and Millon's reaction for detecting albumin constituents of tissues. In 1956, we used the Feulgen, Brachet and the brom-phenol-blue (Hg-Br-Ph-blue) reactions for the differential estimation of albumin particularly for the determination of desoxyribonucleic, ribonucleic and other acids. The fixatives employed were Gilson, Schaudinn's, Zenker's and Carnoy's fluids as well as 96% alcohol (for Feulgen's reaction). Azure-eosin dye according to Nocht-Maximow (after Zenker's) gave very striking pictures. Carbohydrates (glycogen) were detected at first by the iodine reaction (Lugol' solution) and afterwards by a more modern dye (PAS-periodate + Schiff's reagent). Finally, the usual nuclear dyes (Heidenhain's hematoxylin, hemalum) were used for staining microscopic sections. Among all these reagents the most specific for albumin (as Sudan III is for fat) were Feulgen's reaction (for decting desoxyribonucleic acid) Brachet's reaction (for ribonucleic acid) and Hg-Br-Ph-blue (confroming to Mazia, Brewer and Alfert, 1953) for protein in general.

LYMPH AND ITS NONCELLULAR ELEMENTS

By the term hemolymph we, following Kuznetsov (1953), imply the lymph and its formed elements: hemocytes, fat body and noncellular elements (fat granules, albumin, etc.).

The lymph of black flies was not subject to special investigation and we found no information concerning it in the literature.

In black flies the lymph is comparatively abundant and dilute: from light punctures of the cuticle it flows freely in quantities which are large compared with the size of the body. It is subject to sharp fluctuations in volume and during starvation it is much reduced. In the adult insect there is comparatively less hemolymph than in the larva. Examined microscopically the lymph in the larva and hunting female is transparent and colorless. In the pupa and freshly emerged female (in well-fed individuals) the hemolymph is turbid. Under microscopical examination various inclusions are observed of a functional and biochemical diversity, which becomes apparent during the study of their development and by the use of different methods of observation and experiment, the principal of which was vital staining with basic and acid stains.

First of all, in the lymph itself, the use of basic stains revealed dissolved substances precipitating in the form of albumin deposits. Neither desoxyribonucleic nor ribonucleic acid was detected in these albumins by the Feulgen or Brachet reactions. On the other hand, the albumins were dyed intensely in Hg-Br-Ph-blue (proteins).

Transparent, spherical drops of various sizes, more frequently from 1 to 4μ, are conspicuous among the noncellular elements. In fresh, untreated hemolymph, fat and albumin drops cannot be distinguished. But in

some species (Boophthora erythrocephala De Geer., Odagmia ornata Mg. and others) wine-yellow colored droplets of fat are quite visible in fresh hemolymph. These are identical with the droplets of fat in granular hemocytes (see below, page 41) and, according to our observations arise from them during the decomposition of the latter. When the lymph is stained with Sudan III these drops assume an orange color. Simultaneously, a fraction of the fat droplets, until then quite clear and undistinguishable from drops of albumin, are also stained an orange color. They are found in the inner layer of the fat body and in adipocytes and originate when adipocytes disintegrate. In this way fat drops in the lymph have at least a twofold nature and origin.

A proprotion of the droplets remain clear after staining with Sudan III. These are albumin drops. They are not all identical. Some are stained by acid stains, for example trypan blue. Similar drops are observed in depleted protions of the fat body and in aging adipocytes and, evidently, are associated in their origin with the latter. Other drops remain clear in the presence of trypan blue but assume a light bluish tint in Janus green, a crimson tint in neutral red and a blue one with methyl blue. They are not stained in Feulgen or Brachet. Their albuminous nature is demonstrated by their staining in Hg-Br-Ph-blue. Differences in pH in these drops are clearly seen in the presence of neutral red: they are never stained a straw color (alkaline reaction) but always in various shades of crimson (weak intensity).

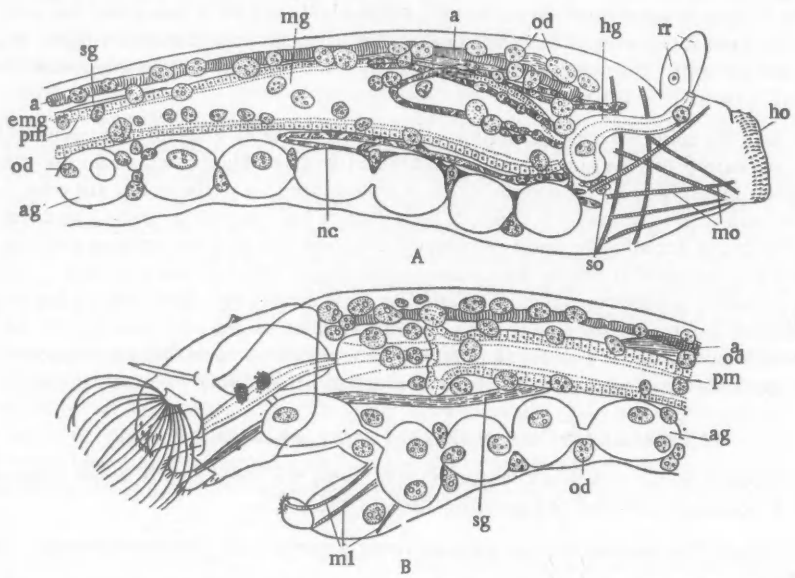

Fig. 1. External structure of 1st stage larva of Gnus relictum Rubz. For explanations see text (page 35).

Besides transparent droplets of fat and albumin, dark colored, (and, therefore, often called pigmented) round or dumbbell shaped granules, about 1 μ in diameter, are always present in lymph. As with the minute droplets of fat and albumin (diameter about 1-2 μ) they are seen to be in intensive Brownian movement. Their albuminous nature will be discussed below during the examination of granular hemocytes (page 37). Pigmented granules enter the lymph when the granular hemocytes disintegrate.

In addition to the formed, noncellular elements already mentioned there are, in the lymph, always a multiplicity of ultramicroscopic particles the nature of which is uncertain.

The quantity of noncellular elements varies considerably in the various phases and stages of development. It reaches a maximum during the period and metamorphosis and in freshly metamorphosed insects during the early part of their adult life. It rises during the periods of ecdysis and after feeding (in the first 24 hours). It is at a minimum in young larvae and in starved or exhausted adult insects. During the periods of maximum

numbers they can be counted in tens or hundreds of thousands in the visual field of the microscope with a magnification of 10 x 40 – and in hundreds of millions in one individual insect. During periods of minimum numbers only dark colored (pigmented) granules are observed, generally singly: drops of fat and albumin as well as soluble albumin may be completely absent.

CELLULAR ELEMENTS OF THE HEMOLYMPH

The differentiation of the inner and outer layers of the fat-body and also the segregation of the rudiments of all the fundamental types of cellular elements is carried out and completed in the period of embryonic development. In the present work, we are not concerned with this period. Questions relating to the origin of the cellular elements of the internal medium are touched upon only in passing and when authentic data are available. Our chief problems concerned the external morphology and certain aspects of the development and functional significance of the more important cellular elements and of the fat body in adults and mature larvae of black flies.

Among the normal cellular elements of the hemolymph in the adults and larvae of black flies the most characteristic are the following: 1) proleucocytes, 2) macroleucocytes, 3) microleucocytes, 4) spindle-shaped hemocytes and phagocytes, 5) oenocytes, 6) oenocytoids, 7) granular hemocytes, 8) adipocytes, 9) outer layer of the fat body, 10) inner layer of the fat body. In addition to these, other cells are met with from time to time, or in one sex only, which cannot be referred to one of the above-mentioned categories.

Proleucocytes (Figs. 4,5, 9 – p).* Minute, spherical cells 5-10 μ in diameter. Nucleus round, comparatively large and measuring more than half the diameter of the cell. The protoplasm appears to be homogeneous and envelops the centrally situated nucleus in thin layers. In neutral red stain minute, round, intensively-stained granules become apparent. Externally, the cells are very similar to mesodermal hemocytoblasts and are observed in the greatest number in larvae which have just molted. They are found in small numbers in larvae of all stages, in pupae and in adult insects. Increase in number coincides with periods of molting, metamorphosis, during the period immediately after emergence and in insects attacked by parasites. Proleucocytes are capable of division. Genetically, these cells seem to be related to those arising during the embryonic development of hemocytoblasts. In 2nd instar larvae, we succeeded in observing mass formation of proleucocytes. Regions of granulation and intensive development of young cells were located segmentally along the sides of the body, principally in the last three segments of the abdomen (Fig. 6, oe). In individual instances up to a thousand cells were counted in each zone of granulation. As they mature, clusters of proleucocytes disintegrate and enter the lymph. Segmental clusters of hemocytes were only rarely observed which seems to indicate the brevity of the process.

Macronucleocytes (Figs. 6, 8, ma). Spherical cells of average size (about 15μ in diameter). Nucleus very large reaching about three quarters the diameter of the cell. The protoplasm thinly envelops the nucleus which is centrally situated and conspicuous in vivo. Stained with neutral red and methylene blue it exhibits minute (about 1μ) granules, apparently albuminous in nature. Nuclear stains show up the nucleus. The number

*Symbols used in Figs. 1-8: a – aorta; acg – accessory gland; ad – adipocyte; ag – abdominal ganglion; al – albumin granule; alc – albumin granules of outer layer of fat body and granular hemocytes; ali – albumin granules of inner layer of fat body and adipocytes; b – bristle; c – cuticle; DNA – desoxyribonucleic acid; ec – egg cell; efb – outer layer of fat body; emg – epithelium of middle gut; et – egg tube; ex – excreta; f – follicle; fal – fat-albumin granule; fc – feeding cells; fd – fat drop; g – glycogen; gh – granular hemocyte; gr – gregarines; h – hemocyte; hg – hindgut; ho – hooks of posterior attachment organ; hy – hypodermis; id – imaginal disc; ifb – inner layer of fat body; ma – macronucleocyte; mg – midgut; mi – micronucleocyte; ml – musculature of thoracic legs; mt – Malphigian tubule; mc – musculature of posterior attachment organ; n – nucleus; nc – nerve cord; nl – nucleolus; p – proleucocyte; pm – peritrophic membrane; pn – pseudonucleus; od – oenocytoid; oe – oenocyte; RNA – ribonucleic acid; rr – rectal rudiment; s – spores; sg – silk gland; so – rudiment of sexual organ; sph – spindle-shaped hemocyte; sr – reservoir of spermatheca; t – tracheole; v – vacuole.

The figures under the individual symboles indicate the successive stages in the development of the various hemocytes or tissues.

of macronucleocytes in the hemolymph is small. They are more often met with when pronucleocytes are plentiful. Macronucleocytes are capable of division and give rise to new macronucleocytes. Genetically, these cells seem to be a stage in the development of pronucleocytes to adipocytes and other cellular elements of the hemolymph. Their function is not clear.

Micronucleocytes (Figs. 4,5,8,9,10-mi). Spherical cells of average size (about 15μ in diameter). The small, round nucleus is set in the center and is very conspicuous in fresh smears and well stained by acid stains. With Sudan III fat droplets are observed, but with neutral red, small, intensively stained, spherical granules (about 2-5μ in diameter) of albuminous nature appear. The protoplasm stains poorly with basic and acid stains. The number of micronucleocytes in the hemolymph is small although, as a rule, they are met with more often than macronucleocytes. Micronucleocytes are capable of division (Figs. 4, 7, mi). Genetically, they are related to proleucocytes. They increase in number in insects attacked by parasites. It is possible that this increase is connected with a protective mechanism. It is also probable that they can be converted into other hemocytes; spindle-shaped hemocytes and phagocytes, judging by the appearance of the intermediate forms (Fig. 4, sph). In some instances hemocytes, similar to micronucleocytes, appear having large vacuoles (Fig. 3, mi) filled with granulations. The functional significance of this phenomenon remains obscure.

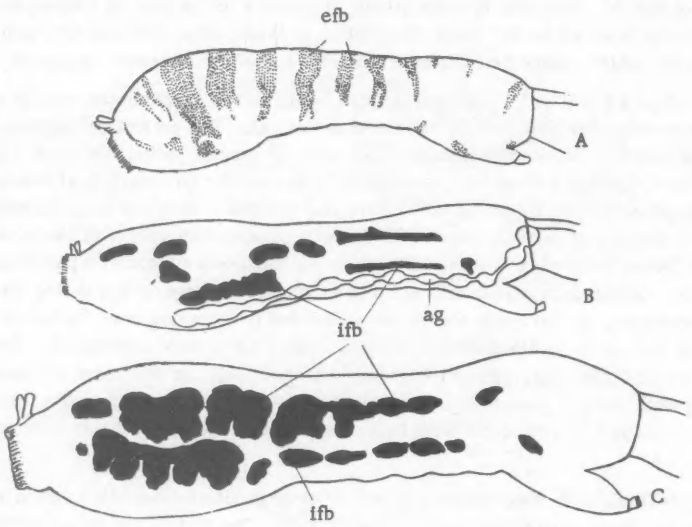

Fig. 2. Fat body. A) Arrangement of the outer layer of the fat body in Gnus cholodkovskii Rubz. (dotted). B) Arrangement of the lobules of the inner layer of the fat body in Odagmia ornata Mg. (wash with India ink). C) the same in Prosimulium alpestre Dor. and Rubz.

Spindle-shaped hemocytes and phagocytes (Figs. 3, 4,6-sph). Drop-shaped, elliptical or spindle-shaped hemocytes (Figs. 3, 4, sph) occurring from time to time in hemolymph, more frequently in close contact with the hypodermis. They are small in size (10-15μ in diameter and about 30μ long). The nucleus is round, its diameter being about half the breadth of the cell. The inclusions in the protoplasm are similar to those in micronucleocytes. Pseudopods are not produced. The function of the cells is not clear. Presumably, phagocytes, outwardly similar to them, are produced. The latter are very uncommon in the hemolymph of the fully grown larva and the imago but are more often met with in pupae. They are easily seen after two days if the body of a larva is pricked, for example, by a rose thorn. On extraction of the thorn phagocytes appear in a mass. Their protoplasm contains small vacuoles. The body is amoeba-like and capable of forming pseudopods. The function of these hemocytes consists, essentially, of ingesting foreign bodies.

The origin of spindle-shaped cells is not evident. On the one hand, a series of intermediate, transition forms indicate some relation to micronucleocytes (Fig. 3, sph). On the other hand, they can be seen in the hypodermis

(Fig. 4, sph) especially in the last chitinous ring (Fig. 6, sph). Whether spindle-shaped cells of different origins are morphologically and functionally identical is not clear. A positive answer to this question is improbable.

Oenocytes (Figs. 4, 5, 6, -eo). Large (50-80μ), round cells rarely met with. The nucleus with nucleolus is about one quarter to one fifth the diameter of the cell (Fig. 5, oe) and is conspicuous in fresh smears. The protoplasm is fine-grained, clear, not wine colored and contains small vacuoles. Oenocytes are found generally in contact with, and among clusters of proleucocytes. The cells are closely connected with the hypodermis in origin and also functionally. At certain periods of their development oenocytes appear to be multinuclear. They are then connected with the hypodermal, connective tissue cells or with adipocytes generally in close proximity to tracheoles. In the first stages of their multinuclear, segmenting development they are in contact not only with the hypodermis, but also with the inner layer of the fat body. Here, clusters of proleucocytes are not seen. The distribution of oenocytes, their morphological relationship with proleucocytes, their contact with the inner layer of the fat body and the time of their appearance help to support the hypothesis that they have a secretory function during the period of blood formation and during development of the fat body (Kuznetsov, 1953, and others).

Oenocytoids (Figs. 1, 5, 6, 8 - od). Oval or round cells, wine-yellow in color and with sharp, regular outline. They evidently become separated while still embryonic. In larvae of the 1st instar they are round and small in size. In older larvae, as well as in the pupa and imago, they reach a size of 20-30μ. The protoplasm is generally wine-yellow in color but sometimes greenish or light brownish. The nucleus is small and round and stains with acid dyes, e.g., trypan blue. The inclusions in the protoplasm are numerous and the various shapes. Small, darkly stained, albumin granules are conspicuous because of their very constancy and abundance. Albuminous, irregular-shaped clumps of various sizes are less often met with. A few, spherical fat drops of various sizes are present. There are also one or more vacuoles staining intensely with neutral red. Besides these, there are small granules whose nature is obscure but which are, evidently, excretory in character. These increase in size and number during periods of intense cell metabolism. Oenocytes are rarely met with singly, but more often in groups in close contact with other tissues and organs. Groups are always present around the salivary gland, in the anterior, glandular section of the midgut, in the sexual organs (ovaries and testes), around the spermatheca and accessory glands and also around the nerve chain. The spermatheca, testes and nerve chain (Fig. 5, od) are often found with an almost complete covering of cells resembling oenocytoids. In the literature they are sometimes referred to as connective tissue. Morphologically, they are close to nephrocytes, arranging themselves along the sides of the aorta and looking like the cells of granular hemocytes. Judging by their similarity and to a great extent by their disposition and changes during the process of development one can infer a close connection of oenocytoids with metabolic processes and growth. From their morphological changes in the midgut directly after bloodsucking, and in the spermatheca soon after impregnation, it seems probable that their function is excretory. Oenocytoids consume their own contents during the development of the cells and organs with which they are in contact. Drops of fat diminish in size and disappear as albumin is formed. On the contrary, the quantity of excretives in oenocytoids increases. Genetically, oenocytes are related to the hypodermis and, evidently, arise from it. More often they are developed in the region of the last three abdominal segments. The ordinary cells of the epithelial layer of the hypodermis develop a fine granulation, growing quickly at first and spreading over the neighboring cells; later they become pear-shaped and hang loose in the body cavity gradually becoming separated and rounding themselves off. Oenocytoids are related to granular hemocytes and to the tissue of the outer layer of the fat body. The cells of the latter can, evidently, be changed into oenocytoids. This change can be observed in certain instances (Fig. 1). In 1st instar larvae of Gnus relictum Rubz. all the cells of the outer layer of the fat body round themselves off and morphologically become indistinguishable from oenocytoids, preserving, at the same time, the arrangement of the cells of the external layer of the fat body (around the nerve cord, along the aorta). The causes of this interesting, pathological phenomenon are not understood.

Granular hemocytes (Figs. 3, 4, 5, 6, 7 - gh). These are the most numerous of the hemocytes and are very different from the other cellular elements. Generally 15-25μ in size. The young cells are oval in shape, the old ones being rounded or having bulges due to inclusions. The color is almost always dark on account of the presence of minute, brownish or blackish granules of albuminous nature. Often the protoplasm itself is tinted light wine-yellow or greenish color. In Eusimilium, it is characteristically light wine or brownish, in Odagmia yellowish and in Wilhelmia it is greenish. The most noticeable inclusions of granular hemocytes, visible in the

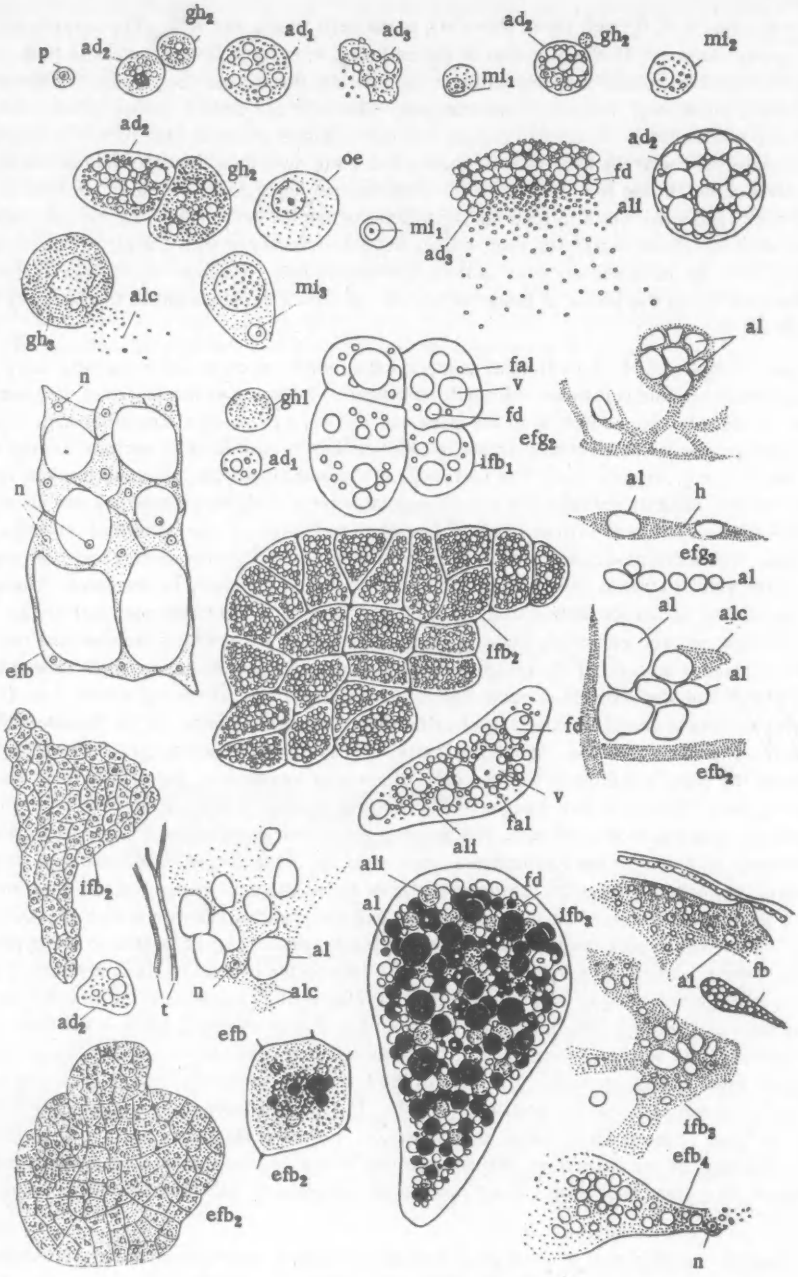

Fig. 3. Hemocytes and fat-body of Gnus cholodkovskii Rubz.

living cell, appear to be pigmented granules, droplets of fat (not distinguishable from vacuoles without staining) and, in young cells, albumin granules. The cell membrane is always clearly defined. The nucleus is invisible in the living cell. It becomes visible in acid stains, for example, trypan blue. It is globular and centrally placed and is about $^1/_3$ the diameter of the cell. Fixed in Schaudinn's fluid and stained with Feulgen the nucleus is blue-violet in color and well seen. As the cell matures the nucleus is displaced toward the periphery and in the old cell it disappears. Fat-albumin clumps are stained a weak rose-violet color (desoxyribonucleic acid) and, in addition, the cell membrane and also portions of the protoplasm surrounding the fat droplets are

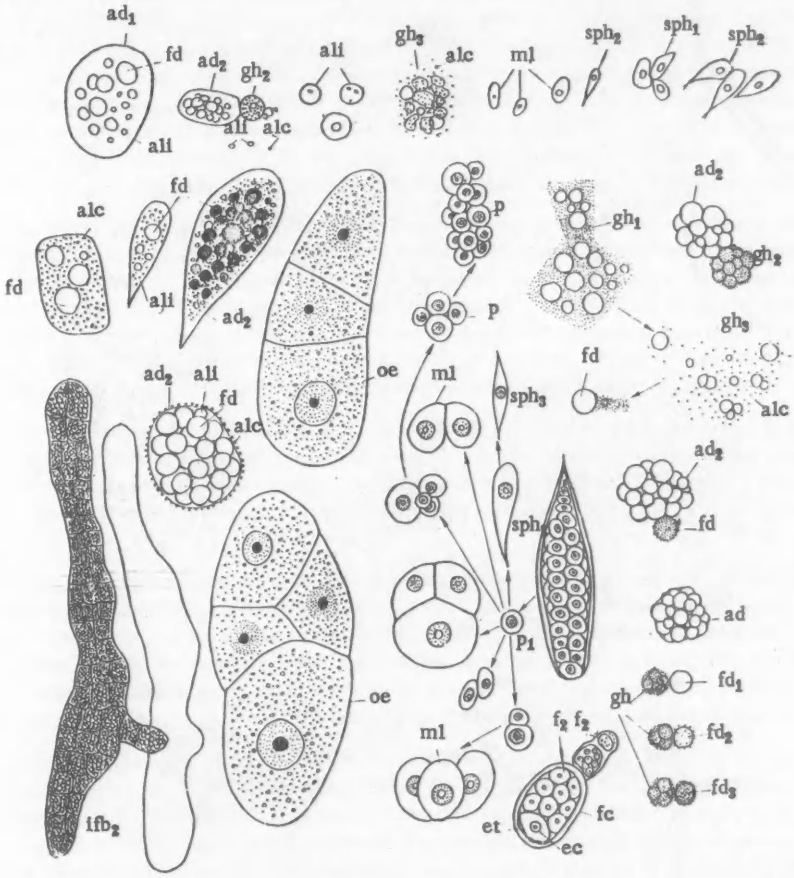

Fig. 4. Hemocytes and fat body of Eusimulium latipes Mg. With arrows showing probable course of development of hemocytes.

stained the same color, but much more intensely. In addition to these, discrete granules among the fat droplets in the protoplasm of the cells are stained a deep violet-red when treated with Feulgen. By this means DNA was discovered, not only in the nucleus, but in other cell elements; as the cell matures the DNA of the nucleus appears to dissolve in the cell. Stained in toluidine blue, after Brachet (reaction for ribonucleic acid), the protoplasm becomes more or less uniformly stained light blue (in Cnephia lapponica End); pigmented granules are also stained bluish; vacuoles light bluish but nuclei are invisible. Granules are stained lighter than protoplasm. None of the elements in hemocytes, except the nucleus is stained by brom-phenol-blue (absence of chromatin). Fixed in Schaudinn's fluid and stained with azure-eosin, according to Nocht-Maximow, the cell protoplasm becomes light blue and the nucleus bluish. Fat drops are conspicuous and readily seen in living cells treated with Sudan III. Their bright orange color distinguishes them from albumin granules and protoplasm which are stained

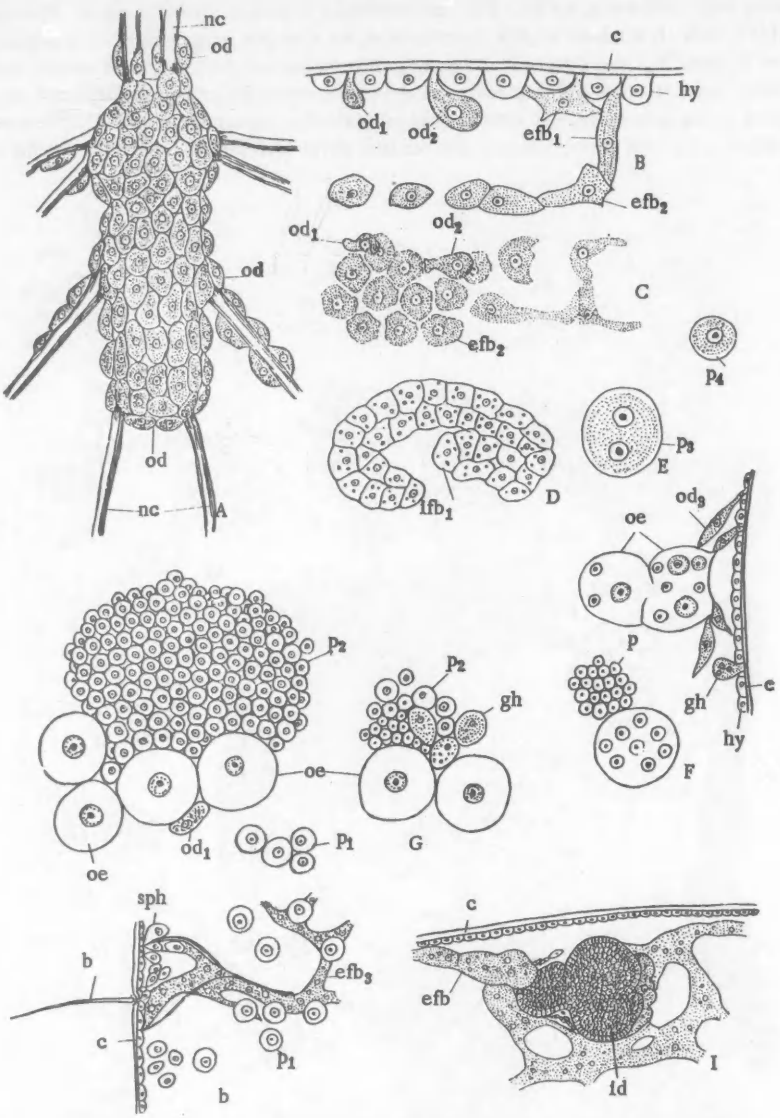

Fig. 5. Hemocytes and their origin in the 3rd stage larva of Eusimulium bicorne Dor. and Rubz. A) Posterior end of nerve chain covered with oenocytoids; B) portion of the hypodermis with part of outer layer of the fat body; C) the same from the side; D) young lobule of the inner layer of the fat body; E) proleucocytes; F) portion of hypodermis with oenocytes and proleucocytes; G) clusters of hemocytes; H) proleucocytes and part of outer layer of the fat body on the hypodermis; I) imaginal disc and outer layer of fat body on the hypodermis.

light crimson in neutral red dye. Fat drops are, as a rule, spherical and of various sizes (3-5-8 μ in diameter); they are very soluble in alcohol and, consequently, appear as clear discs in all preparations involving treatment with alcohol and subsequent inclusion in balsam. The relative numbers of fat drops, their size and biochemical composition undergo sharp fluctuations during the process of cell development. In young cells fat drops

are few and very small. In older cells the quantity of fat is at a maximum but the volume occupied by the fat cells is generally less than half that of the cell. The drops are 1-5μ in size, rarely larger. During cell development the protoplasm liquefies, the fat drops become enveloped by pigment granules and gradually decreases in size finally disappearing altogether like the nucleus.

Among the very noticeable elements of granular hemocytes are pigmented granules. They vary little in size (about 1-5μ in diameter) in all stages of cell development and in all phases of development of the insect. In young cells the granules are smaller and found mainly at the periphery in the neighborhood of the cell membrane, less often in the center of the cell, always in the protoplasm around fat droplets and, sometimes, in the vacuoles or inside the fat droplets. In young cells the granules are motionless (high viscosity of albumin?). With the development of the cells the number of granules substantially increases. The rise in number (without decrease in size) is linked with diminution in the amount of fat. Toward the end of cell development, when fat, nucleus and vacuoles disappear, the whole cell is filled with pigmented granules in intense Brownian movement. That plainly implies the liquefaction of the protoplasm as well as the spherical shape of the cell itself. The concluding stages of cell development are the disruption of the cell membrane and the escape of the granules into the protoplasm (Fig. 6, $gh_{1,2,3}$). During starvation and exhaustion the granules disappear almost completely.

The process of cell development outlined above has been observed and described by many authors working on many insects. For the caterpillar and pupa of the butterfly it is described in great detail by Pospelov (1910). Many authors (summary by Pardi, 1939) have noted the albuminous nature of the granules. We detected albumin after staining with Feulgen and with Brachet which shows the presence of desoxyribonucleic and ribonucleic acids. The reaction for albumin is sometimes masked by the dark color of the granules themselves. Finally, staining the cell with light green (PAS) shows up the numerous granules of glycogen. In young cells they are scattered principally around the nucleus but in older cells around the vacuoles and fat drops (Fig. 7, gh).

The question concerning the mechanism of the multiplication of granules is interesting. In mature cells and especially in the hemolymph the various shapes which the granules assume are easily observed: elongated, constricted in the middle, dumbbell-shaped and, finally, division into two closely connected granules which can be seen to separate (Fig. 6, E, alc_{1-6}). These pictures give rise to the idea that the granules increase by direct division.

In connection with their role in the cells and their fate in the hemolymph one may speculate about the functions of the granules which appear as the final products of cell development. In the cells they appear to be stores of albumin and fat converted into albumin. In the hemolymph they are the most persistent elements even though their numbers sharply and regularly vary. Ideas about the functions of the granules in the hemolymph can be gathered from a consideration of their distribution, their contacts and the modifications of the elements with which the granules come into contact and, lastly, from the mechanism of their numerical fluctuations.

In the hemolymph granules are met with invariably but they are especially abundant during the pupal phase (during the period of metamorphosis). They are usually in contact with fat drops freely floating in the hemolymph. Contacts are increased during periods of intensive expenditure of stores, for example, during starvation. At these periods a variety of phases of contact of granules with fat drops is readily observed. In the first place individual granules are seen on the fat drop which, later, is enveloped by a gradually thickening film. The granules appear inside the fat drop, their number increasing as the drop decreases in size until it finally disappears as if it was being converted into granules. Thus, it is seen that the process is analogous to that which takes place in the granular hemocytes themselves. The granules do not dissolve in water, alcohol, acids or any other reagents used in the staining methods mentioned above. However, it is quite obvious that they are consumed in the processes of vital activities, growth and development, especially in the concluding stages, viz., the development of the sexual products.

This is confirmed by the regular changes in numbers of the granules during the process of development. They already appear in the early larval stages. Their number increases during molting and attains a maximum during pupation. Above all, granular hemocytes are numerous in the pupa and freshly emerged insect. According to the intensity of vital activities, especially during hunger and the period of development of the sexual products, the number is reduced. They are very scarce in the hungry, hunting female and in the male which is completing development of its sexual products. In the hungry, exhausted female both the number of granular hemocytes and the quantity of granules which they contain are at a minimum.

The origin of granular hemocytes is not clear. It is supposed (Rooseboom, 1937) that they originate from young hemocytes (proleucocytes). However, we did not succeed in observing the gradual transition of granular neucleocytes from leucocytes. The young, but already formed, granular leucocytes are constantly present in the hypodermis in close contact with it (Fig. 5, od). The granularity and much larger dimensions of the individual cells of the hypodermis leads to the supposition that they have their origin in the hypodermis, both in the larva and in the adult insect (Figs. 5,6, od). We never witnessed the division of the young granular hemocytes in the hemolymph.

At the same time one should notice the unusual similarity in structure, development and, probably, function of the granular hemocytes with the cells of the outer layer of the fat body.

The overwhelming number of granular hemocytes float freely in the hemolymph. Besides these, a large number are sedentary and found in contact with various tissues, especially with adipocytes (Figs. 3, 4, 5, 6, 7, 8, gh) and the inner layer of the fat body (Fig. 8, gh). Contact of granular hemocytes with individual adipocytes is very often observed during the period of intense growth and development of adipocytes, for example, before and during the period of maturation of the sexual products. The growing and dividing lobules of the inner layer of the fat body are always surrounded by granular hemocytes. They are scattered in the young and in the mature lobules of the fat body and they surround the ovary, spermatheca and nerve cord (Fig. 5, nc). Adipocytes which are in contact with granular hemocytes grow large quickly and accumulate more fat. What is not clear is the duration of this contact and what the adipocytes are in need of during the contact. In fixed and stained preparations (Fig. 7, gh) it is often possible to see, although not always, the shifting of the nucleus of adipocytes in the direction of the granular hemocyte and the more intensive formation of albumin granules. It is obvious that the contact of hemocytes has a functional significance. The character of the observed relationship points to the third function of the granular hemocyte viz., secretory.

It is necessary to record the striking external and structural similarity of granular hemocytes with oenocytoids and nephrocytes, especially in the early stages of development which, in our opinion, indicates community of origin and sustains the probability of the secretory function, pecular, at least, to oenocytoids. In contrast to oenocytoids and nephrocytes granular hemocytes do not accumulate trypan blue, that is, there are no indications of an excretory function such as is found in oenocytes and nephrocytes.

Adipocytes (Figs. 3, 4, 6, 7, 8, ad). These are defined as trophocytes, sphaerocytes (Bogoyavlenskii, 1932), and sphaeroidal cells (Hollande, 1910). After granular hemocytes this is the most conspicuous and common hemocyte of the hemolymph.

It is spherical in shape, often irregularly oval or elongated-oval. In size it is larger than the granular hemocyte, averaging 20-35μ in diameter. The protoplasm is clear, rarely light wine-color or greenish. The nucleus is invisible in the living, unexhausted cell. It is not dyed by vital basic stains (neutral red, Janus green, methylene blue). However, in exhausted cells the nucleus can be dyed a crimson color with neutral red. The nucleus is round (Fig. 7, ad, n). Sometimes two nuclei can be seen in one cell. Its structure becomes more apparent in the reaction for desoxyribonucleic acid (fixation in alcohol or Schaudinn's and staining in Feulgen). Desoxyribose is located in the form of irregular rods (chromidia) principally at the periphery. Nucleoli are also present (Fig. 7, nl).

Globular fat drops of various sizes are found among the visible elements of the adult adipocyte examined in the living condition. Their fatty nature is disclosed by treatment with Sudan III. They dissolved in alcohol and in microscopic preparations treated with alcohol the places occupied by the fat drops appear as clear cavities. By staining and by the action of alcohol it can be shown that, besides fat granules, the cell contains a nucleus, many albumin granules and one or two vacuoles. Albumin granules appear to be the second most characteristic component of adipocytes. The diameters of the cells of one series were 2-3μ. They have a spherical form and clear color and their structure seems homogeneous whatever staining technique is used. Stained with Feulgen or Brachet stains they remain clear, that is, desoxyribinucleic and ribonucleic acids are absent. Ribonucleic acid, in the presence of toluidine blue according to Brachet, appears in the form of small granules (about 1μ) dispersed among the albumin granules. Finally, the albumin reagent Hg-Br-Ph-blue gives a clear blue color to the granules and indicates the presence of proteins. Stained with azure-eosin the albumin granules become rose-violet, that is, a color somewhat intermediate between the color of oxychromatin and cytoplasm. The PAS reaction reveals small glycogen granules in adipocytes. Spherical vacuoles, 1-2 in number are always

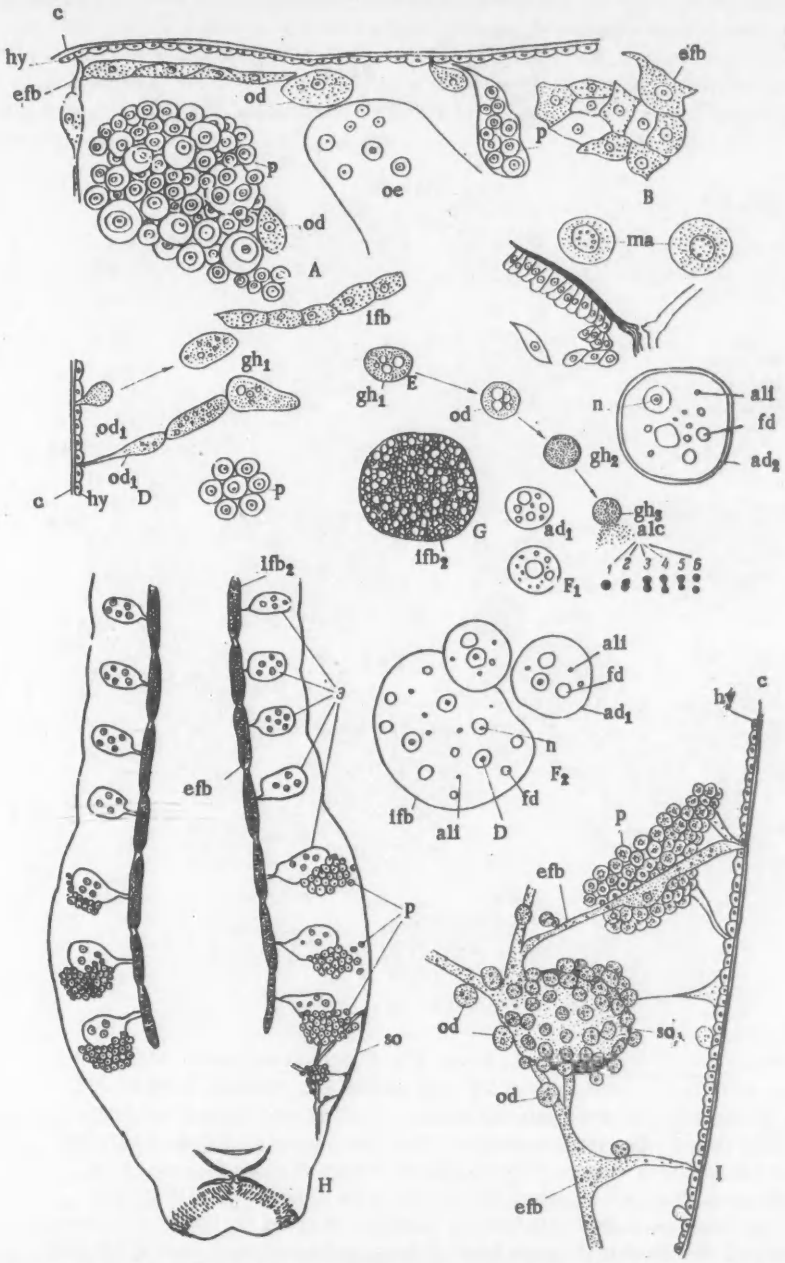

Fig. 6. Foci of blood formation and development of hemocytes in the larva of Eusimulium bicorne Dor. and Rubz. A) Clump of hemocytes under hypodermis; B) portion of outer layer of fat body from above; C) hemocytes at the posterior portion of the body; D) development of oenocytoids; E) development of granular hemocytes; F_1) young adipocytes; F_2) lobule of young inner layer of fat body and adipocytes; G) lobule of inner layer of fat body in fully grown larva; H) arrangement of foci of blood formation in the larval body; I) rudiments of the sexual organs(?) and hemocytes.

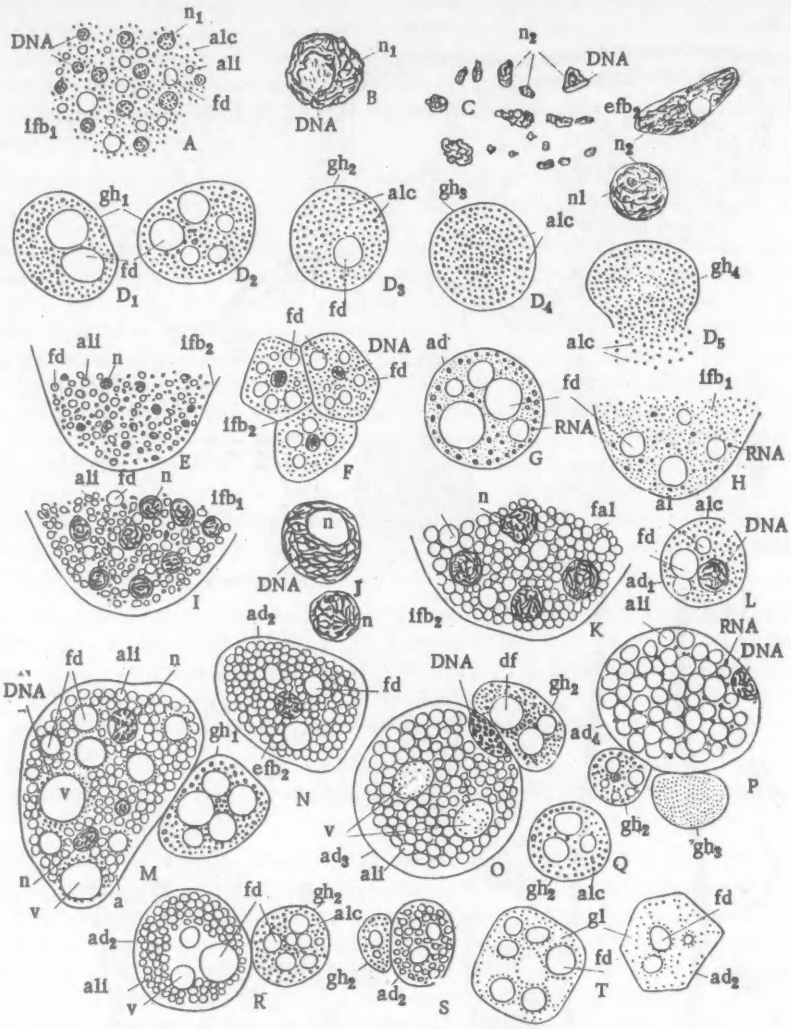

Fig. 7. A-H, Cnephia lapponica End., larva. I-T, Simulium argyreatum Mg., larva and pupa. A) Portion of inner layer of fat body stained with Feulgen; fixed in 96% alcohol; B(nucleus of fat body cell; C) nucleus of cell of outer layer of fat body stained with Feulgen; D_{1-5}) various stages in the development of granular hemocytes stained with Feulgen, fixed in 96% alcohol; E) portion of young fat body, inner layer, stained with Feulgen; F) older cells of inner layer of fat body stained with Feulgen; G) adipocyte stained with Brachet; H) portion of young fat body, inner layer, stained with Brachet, fixed in Carnoy's fluid; I) larva, portion of inner layer of fat body stained with Feulgen; J) nucleus of cell of inner layer of fat body stained with Feulgen; K) pupa, portion of inner layer of fat body, fixed in 96% alcohol, stained with Feulgen; L) granular hemocyte, material and treatment as in K; M) larva, adipocyte with double nucleus, in contact with granular hemocyte, stained with Feulgen; N) larva, isolated adipocyte, stained with Feulgen; O) pupa, adipocyte with granular hemocyte, fixed in alcohol, stained with Feulgen; P) pupa, adipocyte with granular hemocyte, fixed in Carnoy's fluid and stained with toluidine blue according to Brachet; Q) pupa, granular hemocyte fixed in Schaudinn's fluid, stained with azure-eosin; R) pupa, adipocyte and granular hemocyte fixed in alcohol and stained with Hg-Br-Ph-blue; S) the same as R fixed in Carnoy's fluid and stained with Hg-Br-Ph-blue; T) pupa, adipocytes, reaction for glycogen (PAS).

present. In living cells they are indistinguishable from fat albumin drops. However, by the use of vital stains, e.g., neutral red, they become raspberry-colored. Feulgen's reagent shows no desoxyribinucleic acid in the vacuoles. They remains clear and distinguishable from albumin granules only by their larger size (about 4μ). The Brachet reaction generally develops a light blue color in the vacuoles, that is, ribonucleic acid is present in the vacuoles as in the protoplasm. No marked difference in vacuoles and protoplasm was disclosed by the Hg-Br-Ph-blue reaction.

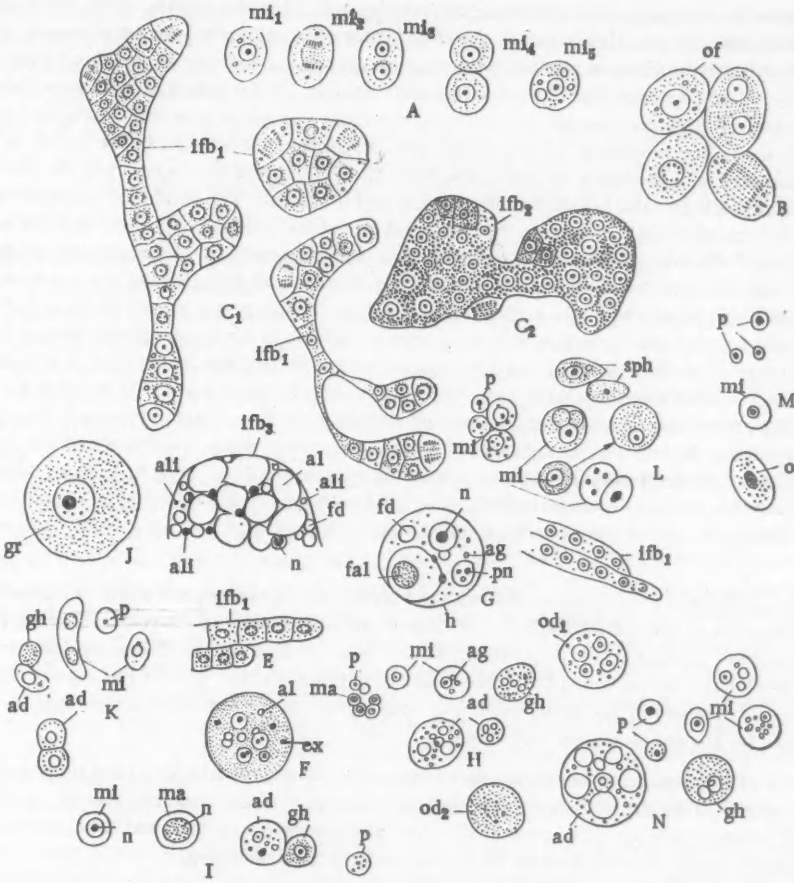

Fig. 8. Hemocytes and fat body of various species. A) Hemocytes of Simulium argyreatum Mg.; B) young lobules of inner layer of fat body in Cnephia lapponica End.; C) oenocytes in Simulium argyreatum Mg.; D-G) Schönbaueria pusilla Fries.; D) portion of lobule of inner layer of fat body; E) clump of young lobules of the inner layer of the fat body; F) aging adipocytes; G) hemocytes; H) gregarine; I) hemocytes in Gnus cholodkovskii Rubz.; J) hemocytes and young lobule of the inner layer of the fat body in Odagmia frigida Rubz.; K) hemocytes in Schönbaueria pusilla Fries.; L) hemocytes in Simulium palustre Rubz.

The changes in the quantities of fat and albumin and also in the sizes and structure of adipocytes which take place during the process of their growth and development are very pronounced. Vacuoles, single grains of albumin and fat were evident in young adipocytes while they were still dividing (Fig. 8, ad). However, fat and albumin comprise an insignificant part of the protoplasm in young adipocytes. The size of the cells is about 15-20μ. The diameter of the nucleus and vacuole, the most conspicuous elements in young adipocytes, is about

one fifth to one third the diameter of the cell. With growth in size of the cell the quantity of fat increases sharply and growth is especially active during the last larval stages. The cells attain a size of 30-35μ. The fat drops consist of a basal mass of young mature cells. In this phase of development the cells have not yet divided. During the period just before their dissolution fats are converted into albumin. A decrease in the number of fat drops and an increase in the number of albumin granules takes place as in the analogous process described for granular hemocytes. The close biological interrelationships between nucleus, vacuoles, fat and albumin granules were, of course, not examined. Nevertheless, structurally, adipocytes are completely different from granular hemocytes. Here, the nucleus, although varying in size shape and position, does not disappear until the end of the cell's life. Desoxyribonucleic acid is confined to the capsule of the nucleus and does not appear round the albumin granules, although the violet color of fat-albumin granules is present as in granular hemocytes. In adipocytes albumin granules originate close to, and around nuclei and side by side with vacuoles and fat drops, but the interrelationship of nucleus with albumin and fat granules is different from that in granular hemocytes. Albumin granules do not surround drops of fat and do not give the cytological picture of the direct influence of albumin granules on fat. Here, the accumulation of albumin in the process of cell development is accomplished, apparently, by some other means. It is possible that, apart from the nucleus, the contact of adipocytes with granular hemocytes has to do with this process. The number of granules increases, as noted, during the period of cell matruation but we never succeeded in observing, either in cells or in hemolymph, the dividing of albumin granules in adipocytes which is so characteristic in the granules of granular hemocytes. The albumin granule in adipocytes differ greatly in size; the tiny granules are strewn among the larger in all cells and, although they were arranged principally in groups, it was impossible to say whether they were distributed according to their situation near the nucleus, vacuoles or fat drops. During hunger the number of albumin granules in the cells is reduced, the fat drops increasing at first, but later almost completely disappearing. Thus, the so-called pseudonuclei appear, being the accumulation of metabolic products – uric acid concretions. Judging from this, albumin can be dissolved and enter the hemolymph by osmosis through the cell membrane of adipocytes. In females, during maturation of the sexual products, the rupture of the cell and the escape of the contents into the hemolymph is a very common occurrence (Fig. 3, ad_3, 6, E, gh_3). There, the nucleus, urinary deposits, fat and albumin residues, quite visible in the unstained, living cell, pass into the hemolymph. Evidently, all the elements undergo solution in the hemolymph and are partially utilized, partly excreted.

Genetically, adipocytes are related at first with the embryonic, mesoderm cells and presumably arise from them by development and differentiation. The largest number of adult adipocytes is observed in adult insects and in larvae ready to pupate; still greater numbers are found in pupae. There are many in freshly emerged adults which have not expended their food reserves. Vital activities, growth and development of the sexual organs are accompanied by the disappearance of adipocytes. In the female with ripe eggs, as in starved individuals, adipocytes are almost completely absent.

The function of adipocytes can be contemplated from this outlined description of the structure, development and the notable fluctuations in their number. The function is, first and foremost, that of reserving stores of foodstuffs: fat, albumin and glycogen consumed in the vital processes of growth and development of the organism, particularly during the period when the sexual products are developing.

The remaining cell elements. Among the hemocytes not belonging to one of the above-mentioned categories are gigantic, spindle-shaped cells reaching a length of about 80-90μ and a diameter of about 30μ which are met with in the male and are seen typically in Gnus cholodkovskii Rubz. With Sudan III fat drops are seen in these hemocytes. When the cells are stained with neutral red, vacuoles and granulations, similar to those observed in glandular cells, are noticed; hemocytes of this class are rare and their function unknown. Their morphology leads one to suspect that they have a secretory function.

A large number of various small hemocytes (from 5μ to 15μ) are seen when the host (larva or imago) is attacked by parasites. Mermis gives one picture, sporozoa another and gregarines a third and so on. The majority of these hemocytes are similar to proleucocytes, macronucleocytes and micronucleocytes in dimensions, form and structure. We think that they arise from macro- and micronucleocytes in such a way that they appear to be their pathological variants. The development and numerical fluctuations of these hemocytes, as well as their functions, were not studied.

Outer layer of the fat-body (Fig. 2, A-efb). The outer layer of the fat body in the freshly emerged 1st instar larva is seen in the excessive development of tissue among the other elements of the hemolymph. It consists of solitary cells under the hypodermis and extends from the anterior edge of the thorax as far as the posterior segments of the abdomen. The segmental grouping of the individual cells is well defined (Fig. 1, A). At first, about twelve cells can be counted in each segment. The grouping is regular as can be seen in Fig. 1, although the details are peculiar for individual species. In the first stages of development, when they are still isolated, the cells are irregularly spindle-shaped, stellate or, less often, round (Figs. 3,4). In dimensions they vary widely from 3-10μ in width and 10-30μ in length. The protoplasm is clear, but sometimes pale, wine-yellow in color. The cells are rich in albumin, fat and other inclusions. The fat inclusions which absorb Sudan III intensively, are seen as spherical drops of various sizes. Sometimes the drops fill the cell touching one aonther and forming little chains.

Albumin inclusions are of two kinds. The first kind consists of darkly stained, "pigmented" granules, generally spherical and about 1μ in size. The second includes clear particles irregular in shape, but generally rounded oval and of various sizes, usually from 2-3μ to 5-7μ. They stain well in basophile stains. Millon's reagent shows them to be of albuminous nature.

Judging by the immobility of the pigmented granules and fat drops the protoplasm is viscous. Besides fat and albumin, vascuoles, staining intensively with neutral red, are found in the cells. In the fresh smear the nucleus is invisible, but becomes visible in basophilic stains. The cells of the outer layer of the fat body in the yound larva of the 2nd instar have a similar character (Fig. 3, efb). Beginning with the 2nd instar the number of cells in the outer layer of the fat body rises quickly. They are connected with the hypodermis. In Fig. 5 (efb_1, efb_2) one can see the broken chains of cells connecting the outer layer of the fat body with the undifferentiated, hypodermal cells. It is characteristic that, among the inclusions in young cells, "pigmented" granules predominate; fat drops are not seen. The nucleus is distinctly seen in the living cell. As the number of cells increase they begin to form rods which fuse into a network. A more or less continuous layer is gradually formed. Where the cells come into contact with one another they become polygonal-shaped (Fig. 5, efb_3). According to their size and development,the cells of the outer layer of the fat body at times become filled with fat drops, at other times they lose them. In the younger stages of development of the larva the cells contain large, albumin clumps (Fig. 3, ag). In older larvae "pigmented", albumin granules predominate. During times of hunger the albumin and fat are consumed. Fat drops and clumps of albumin decrease in size, the protoplasm liquefies and the "pigmented" albumin granules become free. At a certain moment the cell membrane ruptures and the "pigmented" granules enter the hemolymph. The color of the cells varies in the larvae of different species; light yellow, greenish or cinnamon color. It is interesting to note that, besides colored cells, uncolored cells are met with which have neither "pigmented" nor albumin granules but the protoplasm of which is homogenous (Fig. 3, efb). In shape, size the structure of the nucleus the uncolored cells are the same as colored ones. It is important to notice that between colored and uncolored cells no transition forms are seen. Either the cell is clear and completely free of "pigmented"granules or it sis provided with all granular elements.

In the molting period and during pupation and metamorphosis the tissues of the outer layer of the fat body become exhausted. The albumin disappears from the cells and the fat drops become less numerous and smaller.

The cells of the outer layer of the fat body are usually in close contact with the tracheal tubes. One can often trace the end of the tracheole right to the point of growth and development of young cells. The outer layer of the fat body often envelops the trachea and also the imaginal discs in the adult larva (Fig. 5, id). Individual lobules and extensions often connect it with the hypodermis, generally at the points where young hemocytes (proleucocytes) originate (Fig. 5, oe). The number of cells in the outer layer of the fat body increases with larval growth but not to the same extent as those of the inner layer. The quantities of fat and albumin continuously decrease at the time when great changes are observed in the period of metamorphosis. In the adult insect the outer layer of the fat body is well developed and intense in function. "Pigmented"albumin granules are usually abundant directly after the emergence of the imago. Judging from the reactions with Feulgen, Brachet, azure-eosin vital stains (trypan blue, Janus green, neutral red and methylene blue) the outer layer cells of the fat body are very similar, morphologically, to granular hemocytes. Desoxyribonucleic acid is found in the nucleus and around the fat vacuoles, ribonucleic acid in the protoplasm and vacuoles, albumin granules stain with Hg-Br-Ph-blue and so forth. The numbers of individual elements in the cell and their vari-

ations during the process of development and aging of the cells are similar to those for granular hemocytes. Hence, a similarity in their functions in the insect's body is inferred.

The functions of the outer layer of the fat body are diverse, judging from the picture of its development, the structure and contents of the cells the dynamics of the changes in cell contents and its relationships with other tissues. Among its important functions the following seem probable:

(1) storage of fat, albumin and glycogen;

(2) participation in metabolic exchange; assimilation, transformation and dissimilation of albumin and fat;

(3) secretion, concerning young hemocytes and imaginal discs.

The outer layer of the fat-body plays a particularly essential role in the early larval instars. In older larvae and in the imago the storage of foodstuff is carried out generally by other tissues, especially by the inner layer of the fat body.

Inner layer of the fat body (Fig. 2, B, C; Figs. 3, 4, 5, 6, 7, 8–ifb). The inner layer of the fat body in the freshly emerged larva appears as groups of small, round cells (about 5μ in diameter) which become separated while still in their embryonic state but differ very little externally from other mesoderm cells (Figs. 3, 5, ifb). The greatest number of them, sometimes grouped in chain-like form, are seen around the posterior section of the midgut. The segmental arrangement of the cells is similar to that described for cells of the outer layer and, therefore, need not be described again. The over-all dimensions of the inner layer of the fat body in comparison with the outer layer in the 1st instar larva and at the beginning of the 2nd instar are almost the same. The auxiliary inclusions are also very similar. In young cells they are seen as extremely small fat droplets, small vacuoles and granules of albumin (Fig. 3, ifb_1). In the 2nd and 3rd larval instars an intensive growth of of the fat body takes place from which one can deduce a frequency of mitosis (Fig. 8, $ifb_{1,2}$). Numerous mitoses are observed in young tissue (Fig. 8, ifb_2). The extremely varied forms of lobules of the fat body, even in the early stages of development, are noticeable and have a resemblance to individual cells. Sometimes they are arranged in one layer, sometimes in two or three layers, now in extended lobules, now in the shape of mushrooms and so on (Fig. 8). Even in closely related species the developing lobules of the young fat body differ completely in form. As a rule, oenocytoids are found in close contact with the intensively dividing cells of the fat body (Fig. 6, A, od; Fig. 8, B).

In the penultimate larval instar the inner layer of the fat body is small. Only in the last larval instar does it attain more or less significant dimensions: lobules of various sizes are found in all thoracic and abdominal segments but the greatest numbers are concentrated in the posterior part of the body around the hind portion of the midgut (Fig. 2, B, C). At first, according to the quantity of substance in the cells, fat-albumin granules are seen which, subsequently, stain intensively in neutral red and are present with a small number of albumin granules. A characteristic feature of this stage of development of the fat body is the relatively small dimensions of the fat droplets and the reduced size of the cells (about 20μ in diameter). Mitosis was rarely or never seen. The nucleus is not visible among the reserve deposits in the living cell but the cell granules were usually distinct. Contact with oenocytoids is very common. The nucleus is stained by basic dyes, for instance, trypan blue.

In the last larval instars the fat body cells do not increase in number to a marked degree but they become much larger, mainly at the expense or further accumulations of fat and fat-albumin deposits. The dimensions of the cells attain 30–40μ. The individual fat drops combine to form larger ones and sometimes, as for example, in Simulium morsitans longipalpe Belt. almost every cell is filled with one fat drop. The shape of the cells their dimensions, their relative sizes, the number and disposition of the fat drops within them are highly peculiar to each species. The dimensions of the fat-body lobules increase greatly. The number of separate lobules fluctuates around 100. Their arrangement in the body is unique for each species but in size and shape they vary widely in individuals of any one species. The fat body reaches its maximum size at the time of pupation. Its size and, judging by staining reactions, its biochemical composition are not the same in the various species. The inner and outer layers of the fat body are especially large in the caterpillar of phytophagous species. The inner layer of the fat body in Prosimulium alpestre Dor. and Rubz. is, at any rate, twice as large in volume as that in bloodsucking species, for instance, in Gnus cholodkovskii Rubz. (Fig. 2, A, C)

The fully fed larva is transformed into the adult insect when the development of its fat body is completed. In the process of metamorphosis the fat body undergoes a change which is very different in phytophagous and bloodsucking species. In the obligatory, phytophagous species is expended to a greater or lesser degree, at the time of metamorphosis. The female, Gnephia lapponica End. emerging from the pupa, retains only the remnants of the inner layer of the fat body; on the other hand its ovaries reach almost their full development at that time. In species in which the female needs supplementary feeding (blood or plant substances) the fat body undergoes quantitative and qualitative changes; its size decreases if the female lives for a long time without supplementary feeding; it increases appreciably soon after bloodsucking. In the freshly emerged female of the facultative bloodsuckers Boophthora erythrocephala De Geer. and Odagmia ornata Mg. the free fat drops, staining with Sudan III, in the inner layer of the fat body are either not seen at all or only a few are visible. The cells are filled with albumin granules. At first they do not stain with Sudan III. But withing twenty-four hours or more, when maintained under laboratory conditions, fat drops, intensively absorbing Sudan III, appear.

During development and maturation of the sexual products there is always a reduction in size of the fat body; it disappears almost entirely when the sexual products have matured. Hence, one can conclude that the reserves in the inner layer of the fat body are necessary for the ripening of the sexual products, but they can also be used for the maintenance of life during ontogenesis.

Observations on the change of form and contents of the cells by the use of dyes show differences in details in the different species but the general picture is the same. This picture is very similar to that for adipocytes. The reactions for different albumins (DNA, RNA and others) give the same results (see above, page43). During the period of heavy expenditure of reserves (ripening of sexual products, hunger, hunting for prey) almost all the glycogen disappears. After glycogen, the consumption of fat begins. Fat-albumin granules are transformed into granules of fat and albumin. Then the droplets of fat become reduced in size. In place of these there is an increase in the number of clear, albumin granules. The liquid contents of the cells, judging from the decrease in the size of the fat lobules, diffuse into the hemolymph from whence it is used by the various tissues. The rupture of the cell membrane and the mass escape of the albumin granules into the hemolymph was often observed in preparations (Fig. 3, ad). In exhausted females the hemolymph is overcrowded with albumin granules, both in the inner as well as the outer layer of the fat body, just as with fat droplets. During times of hunger and on the completion of development of the sexual products the albumin granules and fat drops disappear from the hemolymph. In depleted cells of the fat body the nuclei are quite visible, also the individual fat drops, granules of albumin and urates (Fig. 8, F).

Vital staining of the inner layer of the fat body reveals a biochemical and, evidently, a functional difference which vary according to the size and form of the individual lobules. Different lobules and different parts of one and the same lobule give different pH reactions which are very noticeable when neutral red is used. As a rule, the smaller lobules diverge and then grow larger in size.

The function of the inner layer of the fat body consists, basically, in the accumulation, transformation and the dispensing of foodstuffs reserves for the maturation of the sexual products. Judging from the occurrence of urate granules in old, exhausted fat cells it must also have an excretory function. Urinary cells were not observed in the fat body of black flies as in other insects. Also, cells with symbiotic microorganisms were not found in the inner layer of the fat body.

SUMMARY

Formed elements present in the hemolymph of blackflies (Simuliidae) can be classified to eleven groups: oenocytes, oenocytoids, granular hemocytes and the outer layer of the fat body (all derived from the hypoderm in the course of postembryonic development), proleucocytes, macronucleocytes, micronucleocytes, fusiform hemocytes, phagocytes, adipocytes and inner layer of the fat body (all derived directly from hemocytoblasts). Micronucleocytes, macronucleocytes, fusiform hemocytes and phagocytes are all derived from externally similar proleucocytes; it is disputable whether these maternal proleucocytes are actually identical; nor has the possibility of mutual transformation of all the above named hemocytes ever been proved. Only young hemocytes (proleucocytes, macro- and micronucleocytes, young adipose cells) are capable of mitotic cell-division. Hemocytes are specialized in functions. Oenocytes are secretory, while oenocytoids are both secretory and excretory hemocytes, phagocytes have protective function, whereas proleucocytes accomplish the function of propagation. The greatest

quantity of nutrients is stored in granular hemocytes, adipocytes and cells of outer and inner layers of the fat body. These layers are essentially different as to their functions. Their relative size and significance are considerably changed in the course of ontogeny. The dark protein granules appear to be the most active component of the granular hemocytes and of the outer layer of the fat body. Nearly all these nutrients are consumed in individual life and in the course of gonotrophic life. The protein nature of the granules, the presence of DNA, their high biological activity, specific stability in size and shape, their permanent presence in ontogenesis as well as their transmission to the progeny, their independent reproduction by direct division, both intra- and extracellular, their functional significance (cleavage and synthesis of fats and proteins), their similarity to bacterial symbionts, widespread among insects, all these characteristics of the protein granules have led the author to the conclusion that they are actually specialized symbiotic bacteroids.

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THE TYPES OF MATURATION OF EGGS IN THE NONBLOODSUCKING SPECIES OF BLACK FLIES (DIPTERA, SIMULIIDAE)

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The females of a number of species of black flies belonging to our fauna possess mouthparts of the nonbloodsucking type and, therefore, do not appear as bloodsuckers. Such females develop their sexual products without recourse to supplementary feeding on blood. In spite of the fact that there are many nonbloodsucking species of black flies in nature, up to now the maturation of their eggs has not been described. The question was first discussed by Rubtsov (1936) since when, in the breeding regions of Prosimulium alpestre Dor. and Rubz., the author notices the absence of attacking females and observed that their mouthparts were similar to those of the male. Later, the question was taken up by Davies (1954) who found, in Norway, a female of P. ursinum Edw. emerging with completely developed eggs. There is no more detailed information on this question in the literature.

Descriptions are given below of the maturation of the eggs in the femals of three nonbloodsucking species: Twinnia sedecimfistulata Rubz., Prosimulium alpestre Dor. and Rubz. and Cnephia lapponica End. which exhibit different types of development of their sexual products and have no need to suck blood.

The work was carried out in 1955-56 in the Irkutsk and Leningrad regions. During the work 225 larvae, pupae and adult females were dissected. Sixty histological preparations were examined. The Christophers-Mer (Christophers, 1911; Mer, 1936) classification, worked out by us for mosquitoes, was used as a basis of classification for the maturation phases of the ovaries and, in general features, it is quite applicable to black flies.

Maturation of the eggs of Twinnia sedecimfistulata Rubz. T. sedecimfistulata was collected from the branches of the river Kotinka, 1.5 km from the small village of B. Koty (Slyudyansk district, Irkutsk region).

The larvae of the older instars of this species have small, weakly developed ovaries. The follicles consist of undifferentiated cells. In the pupa the ovaries contain single, round follicles. The follicular epithelium is separate but unusually thin. According to Christophers-Mer the follicle belongs to phase N_1. The second follicle is still not detached from the growth zone. In the freshly emerged female the ovaries are small. In each of the ovarioles there are two follicles. The egg cell of the first follicle, according to size, is more nourished. Its nucleus is bladder-like with a large, dark nucleolus. The follicle is in phase I. The second follicle is a group of cells surrounded by a thin epithelium (N_1 phase). More often the epithelium is absent and the cells are covered only by the inner coat of the ovariole (N_0 phase). Twenty-four hours after flying the development of the ovary is still in the earlier phase. Further maturation of the sexual products generally proceeds without deviation from the normal at the expense of the rich fat and albumin deposits of the fat body. Egg development is complete on the 9th-12th day.

Maturation of the eggs of Prosimulium alpestre Dor. and Rubz. P. alpestre and collected in the river Kotinka and Chernoi and in the B. Koty valley stream (Slyudyansk district, Irkutsk region).

In the larva with respiratory filaments the ovaries are the same as in the preceding species, small, compact groups intimately surrounded by the lobules of the fat body. In each ovariole there are two follicles.

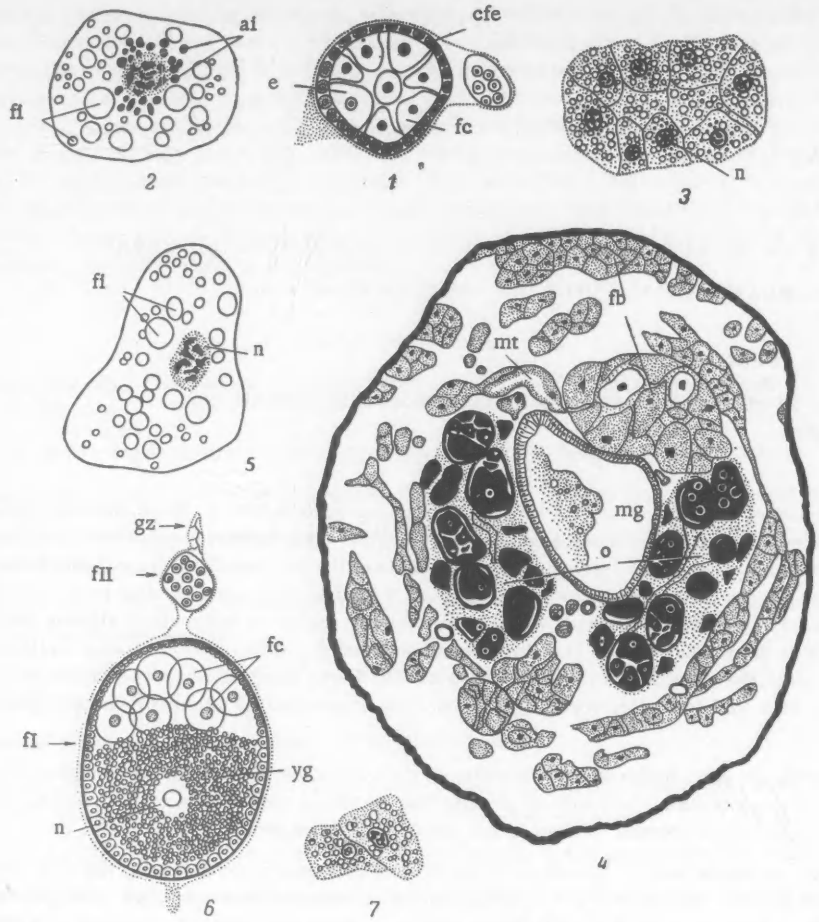

Fig. 1. Condition of ovary and fat body of freshly emerged female of nonbloodsucking species. 1-3) Twinnia sedecimfistulata Rubz.: 1) ovariole; 2) fat cell; 3) part of inner fatty tissue. 4-7) Prosimulium alpestre Dor. and Rubz.: 4) transverse section of abdomen in region of 5th-6th segments; 5) fat cells; 6) ovariole, 7) part of inner fatty tissue. ai – Albumin inclusions; cfe – cells of follicular epithelium; e – egg cell; fI – 1st follicle; fII – 2nd follicle; fb – fat body; fc – feeding cells; fi – fat inclusions; gz – growth zone; mg – midgut; mt – Malpighian tubules; n – nucleus; o – ovary; yg – yolk granules. Fixed in Gilson's fluid, stained in hemalum, magnification -sections 120, individual details 600.

The first, as before, is found to be in phase I and, in rare instances (in 15% of all larvae dissected), in phase IIA. Further maturation of the ovaries takes place in the pupa. The eggs develop from phase I (rarely IIA) in the immature pupa to phase III in the adults. The development is accomplished at the expense of the fat body which, up to the emergence of the imago, shrinks considerably. The female of P. alpestre leaves the pupa with massive ovaries. The first follicle is found to be in phase III. Within 24 hours the follicles expand (phase IV). In four days fully mature eggs, ready for fertilization and laying, are observed in the ovaries. There are no records of this species copulating in captivity. Oviposition did not take place. The females died with developed eggs but without laying them. In nature the eggs are laid probably 5-6 days after emergence.

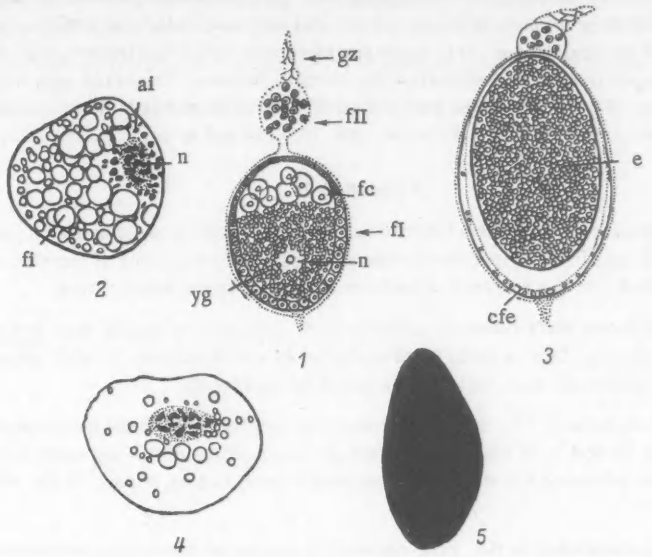

Fig. 2. Condition of ovaries and fat body in Cnephia lapponica End. 1-2) Immature pupa; 1) ovariole; 2) fat cell; 3-4) freshly emerged female; 3) ovariole; 4) fat cell; 5) deposited egg; Remaining symbols as in Fig. 1. From fresh preparations. Magnification 600.

Phases of Metamorphosis of Individuals Studied and the Corresponding Phases of Development

		Type I (T. sedecimfistulata)	Type II (P. alpestre)	Type III (C. lapponica)
Larva	young		N_0	N_0
	mature	N_0	N_1	N_1
Pupa		N_1	I, IIA, IIB, III	I, IIA, IIB, IV
Imago	freshly emerged after pupation	I	III	V
		IIA	IV	Oviposition
	at time of feeding on carbohydrate food and water	IIB	V	
		III	Oviposition	
		IV		
		V		
		Oviposition		

Maturation of the eggs of Cnephia lapponica End. C. lapponica was collected near Leningrad in the river Kamenka near the suburb of Shuvalovo (Pargolovsk district, Irkutsk region).

The ovaries are small in the larva of C. lapponica. The first follicle (phase I of development) attain 60μ. In the immature pupa (on the 2nd-3rd day after pupation) the follicle is already rather elongated (250 x 210μ) and is in phase III. The diameter of the egg cell is 45μ, that of the feeding cells up to 20μ; The latter are of various sizes. Their nuclei are provided with small, dark colored nucleoli. The follicular epithelium in the lower part of the follicle is up to 18μ thick, in the upper part it is rather flattened, up to 15μ thick. In the mature pupa the follicles are found in phase IV. The females of C. lapponica emerge with ripe eggs. Soon after flying (within 45-60 min) the females and males begin pairing. Pairing took place

in small tests tubes (15-25 cm^3 in volume). Copulating pairs were placed on grass and leaves in glass test tubes. Copulation lasted three minutes or more. After copulation had ended spermatophores were retained in the genital orifices of the females for 10-15 minutes. More than 80% of all females laid eggs within 24 hours after flying and copulation. After oviposition the females perished. Deposited eggs were 450 μ long and 310μ broad. The number of eggs laid varied from 250 to 315 and averaged 310. The number of eggs in the gonads varied very little: 142 in the left, 130 in the right, 158-154 and so on.

SUMMARY

Most indigenous species of black flies (Simuliidae) in the USSR have mouthparts of nonbloodsucking type. The maturation of eggs in these species requires no supplementary feeding of females on blood. The development of egg follicles in this species has not been studied up to the present time.

The present investigation was carried out in 1955-1956. The species studied were Twinnia sedecimfistulata Rubz., Prosimulum alpestre Dor. et Rubz. (both collected in the Slyudyansk district, Irkutsk region) and Cnephia lapponica End. (collected near Shuvalovo, a suburb of Leningrad).

The characteristic features of all the nonbloodsucking species are: 1) the development of ovaries at the expense of the larval fat body; 2) the shifting of the principal phases of the egg maturation from the adult phase to the preimaginal phases of metamorphosis (advanced larval instars, pupa); 3) the reduction of the period of adult feeding.

Three types of egg maturation in the nonbloodsucking species of Simuliidae are conventionally distinguished by the author. The first type (represented by Twinnia sedecimfistulata) is characterized by the accumulation of nutrient reserves in the larval fat body, subsequently consumed by the imago in the course of egg maturation. Immediately after the emergence of a female the eggs attain the first phase of maturation.* Presumably this type is primary in origin since it probably has developed earlier than the other types. In the species classified as belonging to the second type (e.g., P. alpestre) the development of the follicles up to the third phase (see reference 1) inclusive takes place in the pupa. Eggs attain maturity on the fifth day after the eclosion. The third type species (e.g., C. lapponica) emerge with perfectly mature eggs that are deposited about one day after the eclosion.

It is possible that under different climatic conditions the same species would have types of egg maturation different from those described, as has been observed by the author in some bloodsucking species. Thus, Wilhelmia equina L. is a bloodsucker in the Bratsk district of the Irkutsk region, whereas in the Luga district of the Leningrad region this species is characterized by the autogenic maturation of eggs, requiring no supplementary feeding on blood. Such facts suggest that the variation in the type of egg maturation within one species of black flies in different parts of its distribution area might prove to be a widespread phenomenon.

It is probable that some nonbloodsucking species have transitional types of egg maturation, intermediate between the types described. The classification of the types of maturation proposed here by the author just outlines principal types of the gonotrophic cycle in the nonbloodsucking species of Simuliidae. Various deviations from these types and transitions between them apparently occur in nature.

The observed fecundity of the species investigated was not high; it was about 100 eggs in T. sedecimfistulata, 150-200 in P. alpestre, and somewhat over 300 in C. lapponica.

The maturation of the second batch of eggs was not observed in any of these species under laboratory conditions. The development of the second follicle never advanced any further than the phase N_1 (see the first citation). By the time the first egg follicle has attained maturity, the exhaustion of the fat body and the adipose cell components of the hemolymph was always complete and apparently irreversible.

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LIFE CYLCE OF HAPLOTHRIPS YUCCAE SAV. (THYSANOPTERA, PHLOEOTHRIPIDAE)

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As yet, information concerning the development of thrips is still very meager. The present article is devoted to the life cycle of the yucca thrips, Haplothrips yuccae Sav.; in it is given a description of all the stages in the development of this species.

Haplothrips yuccae Sav. was described by Savenko (1944) from wingless males and females caught in the Caucasus in the Buknari Kobuletsk district of Adzharsk ASSR; information on the biology and geographical distribution was not included in the account. We know of no other work devoted to this species. Our observations were made on the yucca thrips, in the field and under laboratory conditions, in the Nikitsk botanical gardens during the summer of 1955-1956. At that time, on the southern shores of the Crimea, the yucca thrips was constantly met with in various places from Alushty to Forosa. This is the first time this species has been found in the Crimea.

H. yuccae Sav. feeds on various species of yucca (Yucca recurvifolia Salisb., Y. gloriosa L. and others) and, therefore, appears to be narrowly oligophagous; it lives down in the leaf axils of yucca leaves where, at all times, all stages of development from eggs to adult insects are met with. Plants growing in well-lighted places are colonized by the thrips more readily than those growing in the shade; as a rule, the latter are free from thrips.

We followed the whole life history of the species in our laboratory experiments. It was determined that from egg to adult the insect undergoes five ecdyses. The periods of development for each stage at a temperature of 23-28° C are seen in Table 1.

The whole development from egg to adult insect occupies 30-40 days. The eggs are laid, either singly or in small groups of two to four, on the upper surface of the yucca leaf; by the use of a small brush they can easily be gathered and transferred to a test tube for observations on their further development. As the embryo develops the external appearance of the egg changes; before the egg hatches the red eyes of larva I become noticeable and the posterior part of the egg takes on a pale color. Hatching proceeds quickly. At first the larva frees the anterior part of its body, raises itself up a little and then, swaying itself from side to side, frees the abdomen. On account of its small size and pale color it is difficult to fine the young larva on the leaves of the plant. The young larva grows to the end of its development and becomes yellowish in color.

Larva II, by the end of its life, increases considerably in size, almost attaining the dimensions of the fully grown insect and, at the same time, acquires a pinkish color. It then molts and is transformed into the pronymph which remains within the leaf axil in company with earlier and later stages of the insect.

The pronymph, nymph I and II (3rd, 4th and 5th stages) possess membranous mouthparts and do not feed. These three stages are immobile. If they are disturbed they can move only extremely slowly and clumsily. The adult insect, directly after the molting of nymph II, is pale in color owing to the reddish fat body showing through the integument. The usual dark cinnamon color of the adult is acquired about a day after its emergence from nymph II. The imago of the yucca thrips is characterized by polymorphism in wing development. The majority of the adults are apterous, a small percentage of the individuals have abbreviated wings and, still more

rarely, individuals are met with having well-developed wings. The wings are often broken off owing to the narrowness of the spaces (leaf bases) in which the thrips lives. As in all other members of the suborder Tubulifera the yucca thrips is not capable of jumping, but it can run fairly quickly. In populations of these thrips the number of females is two to three times the number of males, one male fertilizing a number of females.

TABLE 1

Number of Stages and Times of Development of H. yuccae Sav.

Stage	Time of development in days
Egg	5-8
1st (larva I)	11-12
2nd (larva II)	6-7
3rd (pronymph)	1-2
4th (nymph I)	2-3
5th (nymph II)	5-7
Imago	30-36

The yucca thrips is one of a number of phytophagous species feeding on the sap of yucca leaves. In spring, after the cold weather, only adult male and female insects are met with on the yucca. At that time we saw no eggs, larvae or nymphs. According to these observations, we assume that only adult insects overwinter. The number of generations occurring during the course of the year is still not completely known because they follow one on the other, especially during the summer. Thrips which have hibernated begin laying eggs in April but, if the spring is cold, in May. Fresh batches of eggs are found continuously throughout the warm weather until September or even October. Because the development of thrips extend over 30-40 days one may conjecture that there are 3-4 generations in the course of a season.

Egg (Fig. 1) elongated oval in shape. Freshly deposited eggs are the color of pearl, but later they acquire a yellow tint. Chorion smooth. Length of egg 0.45 mm, breadth 0.12 mm (100 eggs measured).

Larva I (Fig. 2). On emerging from the egg the larva is 0.72-0.76 mm long, when fully grown it reaches 1.2 mm (without antennae). The integument of larva I is thin, translucent and weakly sclerotized. The color of the body is milk-white. Clawed legs and 4- to 8-jointed antennae greyish.

Head, as in all succeeding stages, is opisthognathous, large and wide and carries one pare of red, single-faceted eyes. Its length is 0.14-0.15 mm, width 0.08-0.1 mm. Head sutures in larva I absent. The divisions of the head capsule into sections in larva I, as in the succeeding larval and prenymphal stages, is given conditionally by analogy with those in the adult. The head bears the following bristles: sinciput – two pairs, length of first pair 0.017 mm, of second 0.026 mm; frontoclypeal area – two pairs bristles. The 8-jointed antennae are situated on the very anterior edge of the head capsule and directed forwards; their bases are adjacent and separated by a small boss. The 4th-8th antennal joints are greyish. The shape of the joints is seen in Fig. 1C. The sizes of the antennal joints and the number of bristles they bear appear to be a growth characteristic (Table 2).

TABLE 2

Dimensions of Antennal Joints and the Number of Bristles They Bear in Larva I (dimensions given in mm)

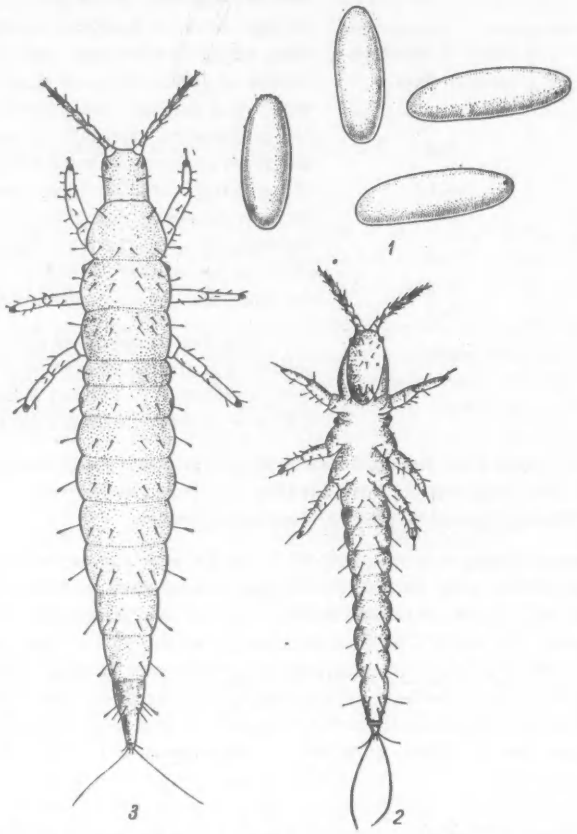
	Number of antennal joints							
	1	2	3	4	5	6	7	8
Length of joint	0.013	0.021	0.021	0.03	0.021	0.017	0.013	0.013
Breadth of joint	0.026	0.019	0.021	0.021	0.021	0.017	0.009	0.004
Number of bristles	1	5	5	4+1S	3+1S	4	5	3

The antennae of larva I, in comparison with the adult forms, are weakly armed with bristles.

The mouth cone, broadly rounded at the end, reaches the middle of the prothorax. The mouthparts, especially the mandible, maxillae and end of upper lip, sclerotized considerably more than the remaining parts

of the head; they are brownish golden in color. The mouthparts are the same as in the adult thrips but differ in their smaller dimensions and weaker sclerotization. Chaetotaxy of the mouthparts: upper lip bears two pairs of bristles, maxillary plate two pairs and lower lip two pairs.

The thoracic segments are much broader than the abdominal and are distinctly demarcated; breadth of prothorax slightly exceeds the length, length 0.11 mm, breadth 0.14 mm. On the anterior angles of the mesothorax a pair of spiracles is placed on a raised membrane. The prothoracic tergite bears a pair of bristles at the



Figs. 1-3. H. yuccae Sav. 1) egg; 2) larva I, seen from below; 3) larva II, seen from above.

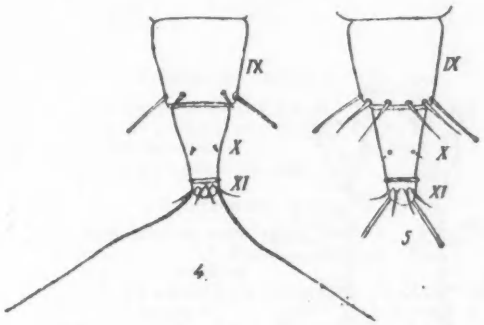
angles of the anterior edge and three pairs on the posterior edge; the length of the bristles on the angles of the posterior edge of the prothorax 0.021-0.02 mm. The sternites, in contrast to those of the succeeding stages, are devoid of bristles.

Legs short, coxa small, wide at the base; trochanter quite inconspicuous; femur as long as the tibia, the latter armed with one long bristle and a row of small ones; tarsus single-jointed with two, dark, sclerotized claws and a vesicle between them.

Abdomen well proportioned, gradually tapering backwards, consisting of ten well-developed segments and a rudiment of an eleventh segment. Abdominal integument thin and having the capacity of stretching greatly when the larva is feeding. However, the sizes of the 9th and 10th segments do not change and are able to serve, together with the size of the head capsule, as criteria for the determination of larval growth. Length of 9th and 10th segments each 0.04 mm; breadth of 9th segment 0.05 mm, 10th segment 0.04 mm

at the anterior edge and 0.02 mm at the posterior edge. The 2nd and 8th segments bear spiracles. The 1st, 8th, 9th and 11th abdominal tergites bear two pairs of bristles each; 2nd-8th have three pairs; 10th has one pair. The 1st abdominal sternite is devoid of bristles; 2nd - 10th sternites carry one pair each. 11th has two pairs (see bottom of page 62, Tables 5 and 6). The bristles on the abdominal segments are long, sharp and arranged longitudinally in regular rows along the body (orthotrichous type of bristle arrangement). The rudiment of the 11th segment on the ventral side terminates in two very long bristles termed caudal bristles; they are 0.17-0.2 mm long.

Larva II (Fig. 3). Length of body of larva II, directly after molting 1.33 mm, at the end of the feeding period the length reaches 1.75-1.8 mm. Integument thin, translucent and weakly sclerotized. During the course of larval life the color of the body changes from yellow to red; this color change is the result not of an accumulation of pigment in the cuticle, as is clearly visible in the discarded skin which is transparent, but of a change in the pigmentation of the fat body.



Figs.4-5. H. yucca Sav., Larva II. 4) End of abdomen from below; 5) end of abdomen from above.

The antennal joints from the second to the eigth and the abdominal segments from the ninth to the tenth are darkened.

The structure of the head recalls that of larva I apart from its greater dimensions. Length of head 0.21-0.23 mm; breadth 0.12-0.13 mm. The chaetotaxy of the head of larva II differs from that of larva I; on the upper part are two pairs of bristles, length of first 0.025 mm, second 0.034 mm. Frontoclypeal area bears two pairs of bristles and one pair of chaetae; three bristles are situated on each genal area.

The antennae differ from those of the first stage in shape (Fig. 11), dimensions and color of the joints; the first joint is whitish, the second and third light smoke-color, the fourth somewhat darker than the foregoing, the remainder dark. The dimensions of the joints and the number of bristles they bear are given in Table 3.

In comparison with Table 2 it is seen that there is a considerable increase in the length of joints 3-6.

Eyes simple, single-faceted.

TABLE 3

Dimensions of Antennal Joints and the Number of Bristles They Bear in Larva II (dimensions given in mm)

	Number of antennal joints							
	1	2	3	4	5	6	7	8
Length of joint	0.021	0.026	0.04	0.04	0.03	0.021	0.013	0.013
Breadth of joint	0.03	0.021	0.021	0.021	0.021	0.017	0.009	0.004
Number of bristles	1	5	5	4+1 S	3+1 S	4	5	3

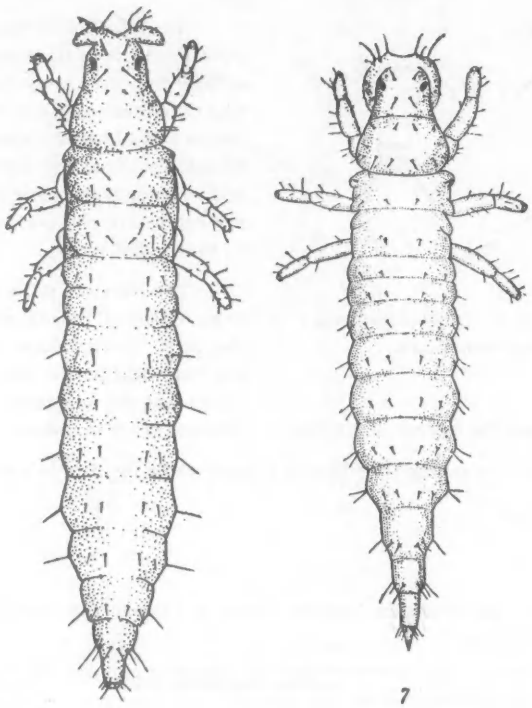
The mouth cone repeats the structure of that of the first stage but differs by its greater dimensions. The chaetotaxy of the mouthparts is as follows: upper lip carries two pairs of bristles, maxillary plate two pairs, lower lip two pairs.

The thoracic segments are as broad as the abdominal segments, clearly separated and not fused together.

The proportions of the prothorax in comparison with those in the first stage larva alter; the segment becomes more elongated; length 0.16 mm, breadth 0.3 mm. Length of bristles on the posterior angles of the prothorax 0.05 mm. On a raised membrane at the anterior angles of the mesothorax is a pair of spiracles. The chaetotaxy of the thoracic tergites and sternites is seen in Table 4; it conforms almost completely to that of the first stage larva, differing from the latter by the appearance of a greater number of chaetae, two bristles on the mesonotum and four on the metasternum. In this stage bristles appear for the first time on the thoracic sternites.

The legs also are as in larva I but their dimensions have slightly increased although, by comparison with the larval body, they are comparatively weak.

The abdomen has a thin, unsclerotized integument; 1st and 2nd segments equal in breadth to the thorax, 3rd, 4th and 5th slightly broader; beginning with the 6th segment the remainder of the abdominal segments become narrower; 10th segment like an elongated cone and bears the name of terminal tube. The size of the 9th and 10th adominal segments is constant; length of 9th segment 0.06-0.09 mm, 10th, 0.064-0.09 mm, breadth of 9th segment 0.06-0.1 mm, 10th , 0.06-0.08 mm at the anterior edge and 0.02-0.03 mm at the posterior edge (Figs. 4 and 5).



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Figs. 6-7. H. yuccae Sav., 6) pronymph, view from above; 7) nymph I, view from above.

The 7th-8th segments carry spiracles. The 1st and 11th abdominal tergites bear two pairs of bristles each, 2nd-9th three pairs, 10th one pair of bristles. The 1st, 2nd, 9th and 10th abdominal sternites each have one pair of bristles, 3rd-8th two pairs each, 11th three pairs.

The chaetotaxy of the abdominal tergites agrees almost completely with that of the first stage larva except that the 8th and 9th segments each bear two secondary bristles. On each of the 1st, 3rd and 8th abdominal sternites are two secondary bristles. The chaetotaxy of the 2nd, 9th and 10th abdominal sternites is the same as that of the first stage larva. On the ventral side of the 11th segment, in addition to the caudal bristles which

are 0.26-0.27 mm long, are four more bristles (Fig. 4). The outer lateral bristles throughout the length of the body in the second stage larva are clavate (Fig. 3).

Pronymph (Fig. 6). Length of body 1.4-1.8 mm. Integument not sclerotized, ground color reddish and dependent upon the color of the fat body which shines through. Antennal cases and legs transparent, colorless.

Head round in front, hind edge fused with thorax without a distinct junction; length 0.2 mm, breadth 0.17 mm. Head carries the same bristles as are characteristic of larva II. Length of sinciput bristles 0.04 mm. Postorbital bristles 0.02 mm long. Clypeofrontal area bears four pairs of bristles.

TABLE 4

Number of Bristles (with number of chaetae in brackets) on the Tergites and Sternites on the Thoracic Sections of the Yucca Thrips

	Larva I	Larva II	Pro-nymph	Nymph I	Nymph II	Female	Male
Prothoracic tergite							
Bristles on anterior edge	(2)	(4)	2(2)	4	2(2)	2(4)	2(4)
Bristles situated on the middle line of the segment	2	2	2	2	2	(8)	(8)
Bristles on posterior edge	6	6	8	8	8	2(4)	2(4)
Mesothoracic tergite							
Bristles on anterior edge	—	2	—	—	—	—	—
Bristles situated between anterior edge and the middle	—	2(4)	4(2)	(2)	(2)	(16)	(16)
Bristles situated on the middle line of the segment	6	6	6	2	2	—	—
Bristles on posterior edge	—	—	—	—	—	(2)	(2)
Bristles at the bases of the anterior wing cases	—	—	—	(1)	(3)	(1)	(1)
Metathoracic tergite							
Bristles on anterior edge	—	—	—	—	(4)	(6)	(6)
Bristles situated between anterior edge and the middle	—	(6)	(2)	(2)	—	(2)	(2)
Bristles situated on the middle line of the segment	6	6	6	2	2	—	—
Prothoracic sternite							
Bristles on anterior edge	—	—	—	—	—	(3)	(3)
Mesothoracic sternite							
Bristles on anterior edge	—	4	4	—	(2)	(4)	(4)
Bristles situated on the middle line of the segment	—	—	(2)	2(4)	2(4)	2	2
Matathoracic sternite							
Bristles on anterior edge	—	4	4	—	—	(16)	(16)
Bristles situated on the middle line of the sternite	—	—	(2)	2	2	2	2

Antennae of all the nymphal stages are free as in the larvae and adults but are invested by cases as in all Thysanoptera.* .Antennal cases of pronymph feebly separated from the head, directed backwards and upwards, slightly curved at the side and carrying three long and two short bristles (Figs. 12 and 13). Eyes absent; in their place are spots of red pigment.

Mouth appendages soft, membranous, fused with one another and not functional.

*Antennal and wing cases are cuticular developments characteristic only of the nymphal stages.

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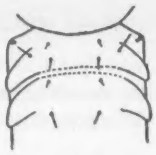

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Figs. 8-9. H. yuccae Sav., Nymph I. 8) Pterothorax with long wing cases; 9) pterothorax with abbreviated wing cases.

TABLE 5

Number of Bristles (number of chaetae in brackets) on the Abdominal Tergites of the Yucca Thrips

	Larva I	Larva II	Pronymph	Nymph I	Nymph II	Female	Male
I . . .	4	4	4	4	4	2(12)	2(12)
II . .	6	6	6	6	6	4(8)	4(8)
III . .	6	6	6	6	6(4)	4	4
						(4)	(4)
						4	4
IV—VII	6	6	6	6	6(4)	4	4
						4	4
VIII .	4	6	6	6	8	(2)	4(2)
IX . .	4(2)	6	6	6	6	12	10
X . . .	2	2	6	6	6	(7)	(7)
XI . .	4	4	—	—	—	5	5

TABLE 6

Number of Bristles (number of chaetae in brackets) on the Abdominal Sternites of the Yucca Thrips

	Larva I	Larva II	Pronymph	Nymph I	Nymph II	Female	Male
I . . .	—	2	—	—	—	2(2)	2(2)
II . . .	2	2	4	4	6	4	4
III—VII	2	4	4	4	6	8	8
VIII .	2	4	4	4	6	2	6
IX . .	2	2	4(4)	4(2)	6	—	4
X . . .	2	2	8?	2(6)	2(6)	(8)	(8)
XI . .	4	6	—	—	—	12	12

Chaetotaxy of the mouthparts as follows: upper lip carries two bristles; each maxillary plate has two bristles; lower lip four bristles.

The boundaries of the thoracic segments are not clearly marked, the most distinct being between the pro- and mesothorax. On the dorsal side of the meso- and metathorax definite tergal sclerites are found. Length of prothorax 0.17 mm, breadth 0.21 mm. The pronotum of the pronymph carries two bristles more than that of the larva II. In other respects the chaetotaxy of the thoracic tergites of the third stage agrees with that of the second stage; as is seen in Table 4, a change is observed in the number of chaetae. Bristles longer than in Larva II. The presence of four bristles on the meso- and metasternum is characteristic of this stage.

The legs are represented by only four joints, the trochanter is not differentiated. Tarsus with one joint and two sclerotized thickenings in the form of claws, vesicles on the tarsus weakly developed. Femur and tibia of similar size, femur thicker than the tibia. Bristles on the femur, and particularly on the tibia, fairly long.

Abdomen with thin, unsclerotized integument; boundaries between the abdominal segments smoothed out. Beginning with the 7th segment, in a backward direction, the abdominal segments become narrower. The 11th segment is represented by a very small lobe which is devoid of bristles, including the caudal bristles. Abdominal spiracles absent. The first abdominal tergite bears two pairs of bristles, 2nd-10th three pairs bristles. First abdominal sternite has no bristles, 2nd-9th each have two pairs of bristles, 10th four pairs. Thus, the chaetotaxy of the abdominal tergites differs from that of larva II in having four additional bristles on the 10th segment. The chaetotaxy of the abdominal sternites differs from that of larva II in the presence of four bristles on the 2nd and 9th segments and eight on the 10th segment. The longest bristles on the 10th segment attain a length of only 0.04 mm. Clavate bristles, which are characteristic of larva II, are absent in this stage.

Nymph I (Fig. 7). Length of body 1.42-1.8 mm. Body integument unsclerotized, ground color reddish depending upon the color of the fat body which shows through. Antennal cases, wing cases and legs transparent and colorless. Head rounded in front, posterior edge fusing with thorax without a definite boundary. Length of head 0.17 mm, breadth 0.13 mm. Head carries the same bristles as are characteristic of the third stage (pronymph). Length of first pair of sincipital bristles 0.026 mm, second pair 0.03 mm. Postocular bristles 0.021 mm long. Clypeofrontal sclerite bears four pairs of bristles.

Antennal cases longer than in the pronymph, lying on the side of the head and not reaching the boundary between head and prothorax; chaetotaxy of antennae as in the pronymph (Fig. 4). Eyes in the form of clear,

dark colored, pigment spots situated on the upper side of the head; facets absent, mouthparts soft, membranous, completely fused together and not functional. Upper lip carries three pairs of bristles, maxillary plate three pairs, lower lip two pairs.

The boundary between prothorax and mesothorax is clearly marked. Meso- and metathorax are fused, the boundary between them hardly noticeable, spiracles are situated on the anterior angles of the mesothorax. In this stage wing cases appear; in the various individuals they are distinguished by their size, namely: in the nymph from which the imago arises the wing cases are fairly long, almost reaching the posterior boundary of the second abdominal segment, in the nymph from which individuals with reduced wings arise the wing cases are very small, in the shape of small projections (Figs. 8 and 9). The pronotum carries seven pairs of bristles, one pair more than the number on the pronotum in the third stage. The chaetotaxy of the meso- and metathoracic tergites differs from that of the pronymph in the reduced number of bristles; each of them bears one pair of bristles, in addition to which a pair is found at the base of the wing cases. Prothoracic sternite, as in all the foregoing and succeeding stages, has no bristles. On the meso- and metathoracic sternites are situated two bristles, that is, two bristles less than in the preceding stages.

The structure of the leg, as in the pronymph except for the larger size of the vesicle of the tarsus.

The anterior abdominal segments are the same breadth as the thoracic segments; beginning with the sixth, in a backward direction, they gradually become narrower, the boundaries between the segments being clearer than in the pronymph. The rudiment of the 11th segment is conical, in contrast to that of the preceding stages in which it has the form of a round lobe devoid of bristles. Abdominal spiracles absent.

The first abdominal tergite bears two pairs of bristles, 2nd-10th each have three pairs. The 1st abdominal sternite has no bristles but 2nd-9th each bear two pairs of bristles; underneath the 10th segment three pairs of small and one pair of long bristles are situated. Thus, the chaetotaxy of the abdominal tergites and sternites is the same as that in the pronymph (Tables 5, 6).

Nymph II (Fig. 17). Length of body 1.5-1.8 mm. Integument not sclerotized; ground color of body dark red with isolated white spots. The color, as in the preceding stages, depends upon the fat body showing through. The antennal and wing cases and also the legs are completely transparent. The boundary between the head and prothorax is seen much more distinctly than in the preceding stages. Length of head 0.19 mm, breadth 0.13 mm. The number of bristles on the sincipital area is the same as in nymph I, namely two pairs. Length of first and second pair of sincipital bristles 0.04 mm, length of postocular bristles 0.06 mm. They are greatly increased in size compared with the preceding stages. Frontoclypeal area carries four pairs of bristles.

Antennal cases elongated, lying along the lateral sides of the head as far as the prothorax and passing on to the ventral surface.

Prior to the molting of nymph II the developing antennae of the adult insect clearly show through the integument of the cases (Fig. 15).

Eyes, as in nymph II, appear as small accumulations of pigment about the size of the eyes of the adult thrips. Mouthparts, although membranous, are not functional but develop further than those in nymph I (Fig. 18). Upper lip carries three pairs of bristles, maxillary plates two pairs and lower lip two pairs.

Prothorax with rounded lateral sides is clearly separated from the head and mesothorax; pronotum has six pairs of bristles. Meso- and metathorax completely fused and forms the pterothorax. The boundaries between them are scarely marked; mesonotum and metanotum each bear two bristles. Prosternum is devoid of bristles, mesosternum and metasternum each carry two bristles. Spiracles situated on the anterior angles of the mesothorax, simple, without sieve plates. Wing cases of some individuals are short, not reaching the posterior edge of the metathorax; in others they are much longer, reaching the middle of the fourth abdominal segment (Fig. 19). The wing cases of the metathorax provided with three bristles, those of the metathorax have no bristles. The structure of the legs is the same as in the foregoing nymphal stages. The number of bristles on the legs is greater than in nymph I, the length of the bristles at the same time increasing.

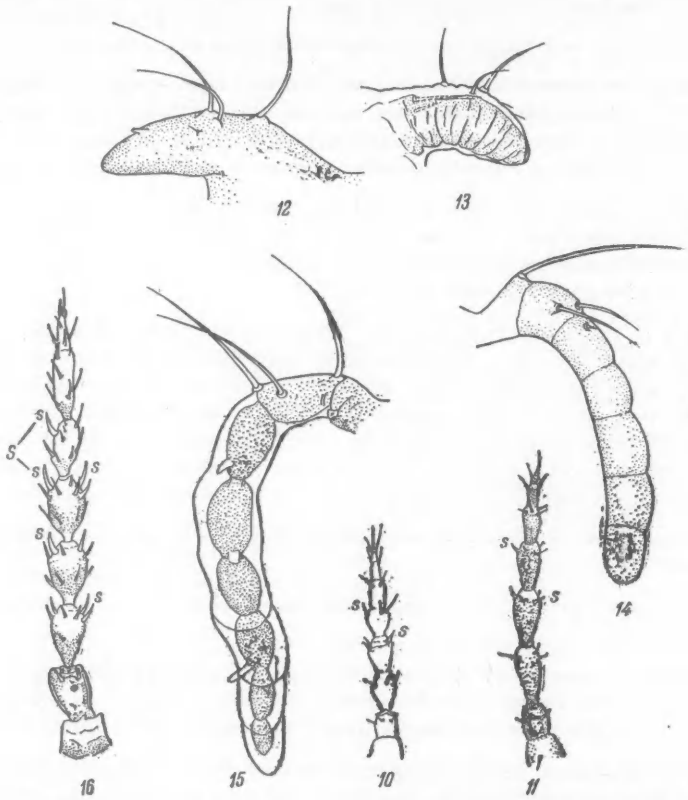
The abdomen is the same width as the thorax, gradually tapering to the end; the boundaries between the individual segments are well marked on the lateral sides of the abdomen and faintly marked medially on the dorsal and ventral sides. Rudiment of 11th segment conical. Abdominal spiracles absent. The 1st abdominal

tergite bears two pairs of bristles, 2nd, 7th, 9th and 10th each carry three pairs, 8th four pairs. The abdominal sternites from 2nd-9th each have three pairs of bristles, one pair more than in the preceding stages; 10th has one pair of bristles.

At the end of the development of nymph II the adult insect, forming inside, shines through the integument; the antennae, wings and 9th and 10th abdominal segments are particularly clear.

Imago (Fig. 20). Length of body of males 1.2-1.4 mm, females 1.6-1.8 mm.

The adult insect differs from the nymphal stages by the much greater sclerotization of the integument. Color dark grey to blackish grey. Variations of color take place in the adult stage due to the accumulations of pigment in the cuticle. 1st and 2nd joints of the antenna greyish, the 2nd with a light vertex, 3rd-6th yellowish, 7th and 8th dark grey. Tibia of forelegs yellowish with a dark base, middle and hindtibia and the femurs of all legs dark grey, tarsi yellow. Body bristles light.

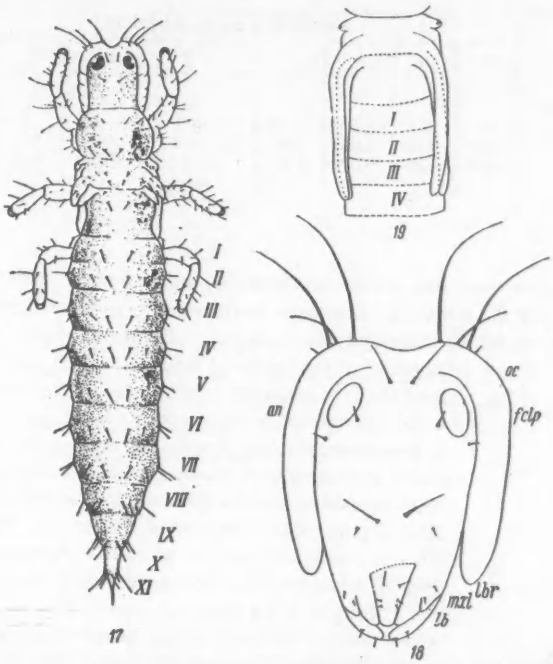


Figs. 10-16. H. yucca Sav. 10) Right antenna of larva I; 11) the same of larva II; 12) right antenna of pronymph; 13) antenna of pronymph before molting; 14) left antenna of nymph I; 15 antenna of nymph II before molting (the antennal segments of the adult thrips show through; 16) antenna of adult thrips; s – sensillae.

Head (Figs. 23, 24) of H. yuccae Sav. opisthognathous. From above it is a little longer than the prothorax and clearly separated from it. Length of head 0.23 mm, breadth 0.21 mm. The dorsal (sincipital area) surface of the head carries a smaller number of bristles than that of the nymph, namely, one pair of long, postocular bristles, 0.05-0.06 mm long, projecting beyond the boundary of the head and about 10 12 pairs of chaetae. The ventral surface (frontoclypeal area) is covered with a large number of chaetae. In the preceding

stages there are fewer of them; besides chaetae, a pair of long bristles is situated here in an asymmetrical manner (0.03 mm).*

The antennae are placed on the very anterior edge of the head capsule; their bases are separated by a small ridge. In contrast to the larval antennae they are distinctly jointed, consisting clearly of eight joints (Fig. 16). The sizes of the joints and the number of bristles they carry are given in Table 7.



Figs. 17-19. H. yuccae Sav., Nymph II. 17) View from above; 18) facial area of head; 19) pterothorax; lbr – upper lip (labrum); lb – lower lip (labium); mxl – maxillary plates; fclp – frontoclypeal area; oc – eye spots; an – antennal cases.

Comparing Table 3 with Table 7 it is seen that all the antennal joints in the imago are considerably larger than those in larva II, their armature of bristles is richer, the number of sensillae increase and the second joint is provided with clear pits which are round in shape and, evidently, the sites of chemoreceptors. On each of the third, fourth, fifth and sixth joints is a pair of conical sensillae.

The compound eyes are large and occupy a considerable portion of the lateral and dorsal sclerites of the head (one third the length of the head). The eyes contain 65-70 facets, each of which is convex and separated from its neighbors by narrow portions with no facets; they bear chaetae. Between the eyes, on the sincipital surface, three ocelli are placed.

The mouth apparatus is typical of the suborder Tubulifera, its structure, similar to that of the larva, differs from it by the larger size of all its parts and the greater sclerotization.

*In the present article the head of thrips is divided into sclerites according to Snodgrass (1935); Reijne (1927) considers the frontoclypeal sclerite as the frons; Jones (1954) considers that the facial sclerite consists only of the clypeus; the frons does not participate in the formation of the facial sclerite and should be limited, in his opinion, to the small region on the dorsal side of the head: the area of the median eyes and a small portion of its surroundings.

Distal end of the mouth cone round, reaching half the length of the prothoracic sternite. The structure of the mouthparts is typical of the suborder Tubulifera and differs from the larval mouthparts by their greater dimensions and heavier sclerotization (Figs. 25-27).

TABLE 7

Dimensions of the Antennal Joints and the Number of Bristles They Bear in the Imago (dimensions in mm)

	Number of antennal joints							
	1	2	3	4	5	6	7	8
Number of bristles and sensillae	2	8	8+2S	10+2S	14+2S	10+2S	8	6
Length of joint	0.03	0.04	0.05	0.05	0.04—0.05	0.04	0.04	0.03
Breadth of joint	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.009

In the structure of the mouth cone there are four components; upper lips, the proximal part of the left mandible, the maxillary plate and the lower lip. The upper lip (labrum) is asymmetrical, sclerotized toward the tip and converted into a sheath for the piercing stylet; it carries eight bristles above; the lower edge of the upper lip at the left basal angle is arched; here, the enlarged basal portion of the mandible is situated. The left mandible is well developed and consists of two pieces: a basal expanded part and a strongly sclerotized piercing stylet. The base of the mandible is provided with a helical-shaped thickening which serves for connection with the upper lip and possesses a special hook for this purpose; the right mandible is preserved in the form of a rudiment. The rudiment represents the very basal portion of the mandible and fuses with the upper lip forming a bulge on it. Both maxillae are well developed. Each consists of a stylet and a maxillary plate. The maxillary plates form the lateral sides of the mouth cone, wedge-shaped at the top and abutting on the upper lip with reinforced lateral edges and provided at the top with a two-jointed maxillary palp. The weakly sclerotized portion of the maxillary plate carries four bristles. The inner maxillary stylets are long, grooved and lightly sclerotized. The lower lip forms the lower wall of the mouth cone and consists of two sclerites clearly divided by a suture. The proximal sclerite is called the postmentum, the distal one the prementum,* on which a pair of feelers is placed, each feeler consisting of one joint and a small basal piece, as appears in the palpigradi. Prementum provided with three pairs of bristles. The compound, membranous lobes of the lower lip are here interpreted as paraglossae (Reijne, 1927; Melis, 1939). Glossae are absent; the portion between the glossae is occupied by the distal ends of the hypopharynx. The hypopharynx has the form of a sclerotized channel.

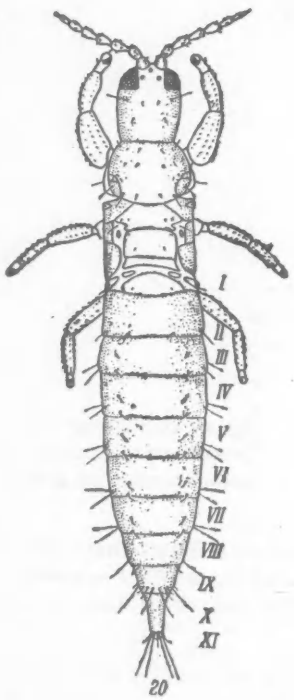
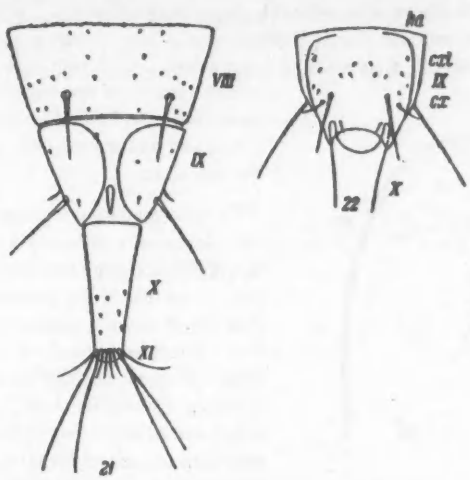


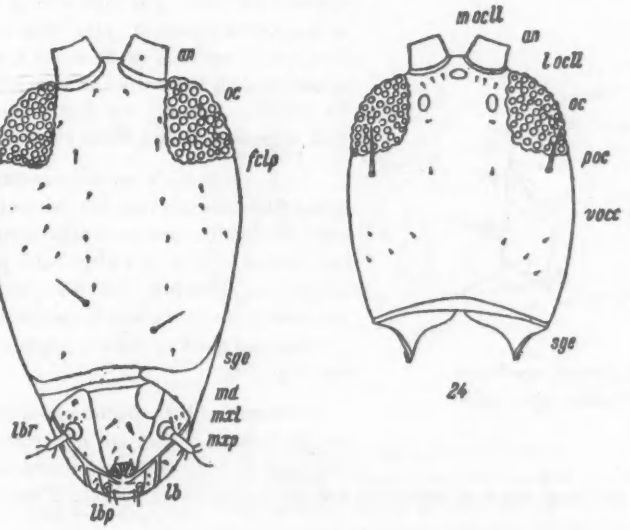
Fig. 20. H. yuccae Sav., adult thrips from above.

The thorax is divided into prothorax and a complex pterothorax. The prothorax freely articulates with the head and there is no cervical sclerite. The pronotum is represented by a whole sclerite with a straight front edge and concave lateral edges to which are joined the epimeron and the episternum (Fig. 28). At each of the anterior and posterior angles of the pronotum a bristle is located. Length of bristle at anterior

*According to the terminology adopted by us (Snodgrass, 1935); Reijne (1927) considers the proximal sclerite as the submentum, the distal one as the mentum.

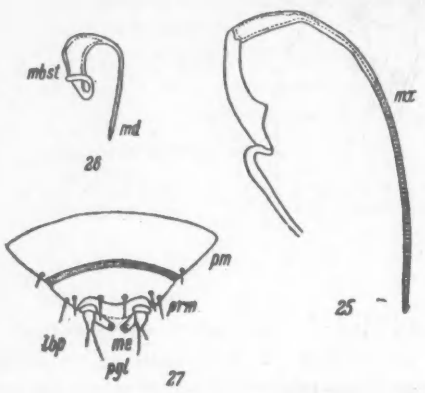


Figs. 21-22. H. yuccae Sav. 21)Female 8th-11th segments from below, showing chitinous keel; 22) male, 10th segment from below. cxl – coxal lobe or distolateral branches; cx – coxites; ha – hypandrium or subgenital valve.



Figs. 23-24. H. yuccae Sav., imago. 23) Head from below; 24) head from above. an – 1st antennal joint; fclp – frontoclypeal area; mxl – maxillary plates; locll – lateral ocelli; lbr – upper lip (labrum); lb – lower lip (labium); lbp – labial palp; mocll – median ocelli; oc – compound eye; poc – postocular bristles; sge – subgenal area; vocc – occipital area.

angle 0.028-0.038 mm, bristle at posterior angle 0.05-0.06 mm. Meso- and metathorax fused into the pterothorax although their sclerites remain separate. Mesothoracic tergite displaced in front in relation to the pleurosternal region and moved backwards together with the coxae of the hindlegs. Mesonotum represented by one complete sclerite and it may be surmised that it is made up of fused prescutum and scutum; at the side is a faintly marked suture which separates, apparently, the scutellum. Postnotum reduced to a narrow fold. Metanotum consists of two unequal plates; the anterior, almost twice the breadth of the posterior, consists of fused prescutum and scutum, the posterior is, to all appearances, the scutellum.



Figs. 25-27. H. yuccae Sav. 25) Maxillary stylet; 26) left mandible; 27) lower lip, external view. lbp – labial palp; md – mandible mx – maxillae; me – membrane; mbst – weakly sclerotized basal stylet of mandible; pm – postmentum; prm – prementum; pgl – paraglossae.

The prothoracic pleurites are small with triangular, elongated episternum and a much larger, approximately square epimeron having one clavate bristle. The pleural portion of the pterothorax is composite and the absence of definite pleural sutures confuses its interpretation. The mesopleural sutures terminate in a straight line from the coxal joint to the sites of attachment of the forewings (Snodgrass, 1935; Jones, 1954). In front of the suture are situated four episternal plates, two of which represent the proepisternal plates the other two being, two of which represent the proepisternal plates the other two being, strictly, the episternites. Between them the mesothoracic spiracles, elongated-oval in shape, are placed. The episternum is subdivided into subepisternum (infraepisternum) and a larger, dorsal plate, the supraepisternum. Behind the mesopleural suture is found the mesepimeron which is divided into infraepimeron and supraepimeron, the latter being connected with the metathoracic spiracles. The metapleuron consists of two elongated sclerites separated by the pleural suture. The sclerite situated ventrally to the suture appears to be the metaepisternum. It is fused with the metasternum. The sclerite situated dorsally, which is narrow and well differtiated, appears to be the metaepimeron (Fig. 31).

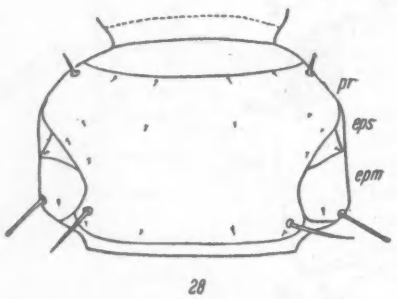


Fig. 28. H. yuccae Sav., imago, prothorax from above. epm – Epimeron; eps – episternum; pr – pronotum.

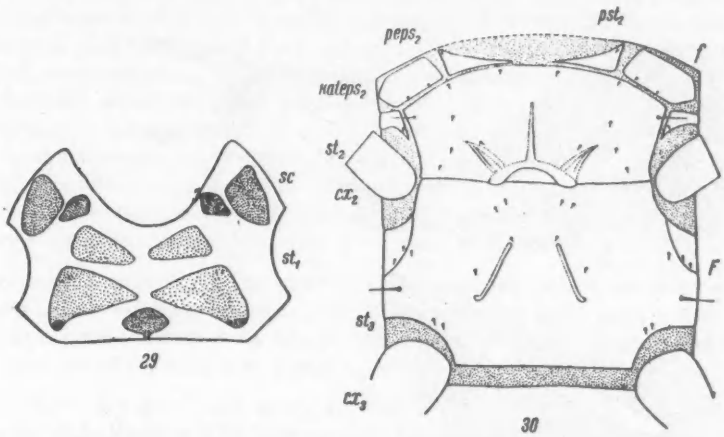
The prothoracic sternite consists of a membrane upon which nine sclerites are placed (Fig. 29). The mesothoracic sternite consists of three sclerites, two triangular ones placed in front of a large basal plate with a transparent, forked, endoskeletal bar at the posterior edge. The metathoracic sternite is complete and unbroken into sclerites and has longitudinal ridges on the medial portion (Fig. 30).

Wings* of both species are either completely absent (f. aptera), or they are abbreviated and do not reach the posterior edge of the pterothorax (f. brachyptera); in a portion of the females the wings are well developed and the normal length, reaching the 7th-8th abdominal segments (f. macroptera).

In connection with the appearance of these three forms in one species Trybom (1896, 213-229) distinguishes ten groups, or categories, among which were assigned the then, well-known species. H. yuccae Sav. does not fit exactly into any one of these categories, but belongs, partly to the third, partly to the sixth. In the third group, according to Trybom, are related species among which the males are apterous and the females partly

*The species was described only from apterous individuals (Savenko, 1944).

apterous and partly with fully developed wings; to the sixth group belong species in which the males have rudimentary wings, the females having either rudimentary or fully developed wings. Normally, the wings in the yucca thrips are typical for the order Haplothrips, being short and having a slight reduction in width in the middle. This contraction appears to be one of the characteristics of the family, but in the yucca thrips it is only slight (Figs. 32-34).



Figs. 29-30. H. yuccae Sav. imago. 29) Prothorax from below; 30) pterothorax from below. cx – Coxa; f – mesothoracic furca; $kapets_2$ – subepisternum; pst_2 – prosternum; peps – proepisternum; sc – sclerite; st_1 – sternite.

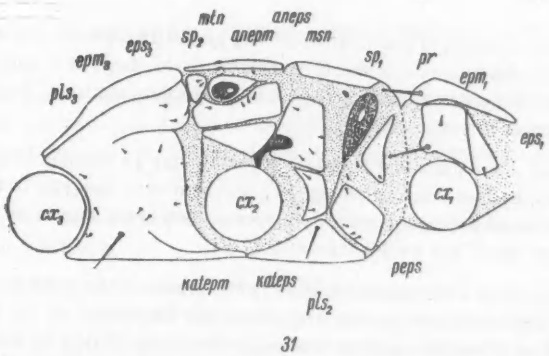
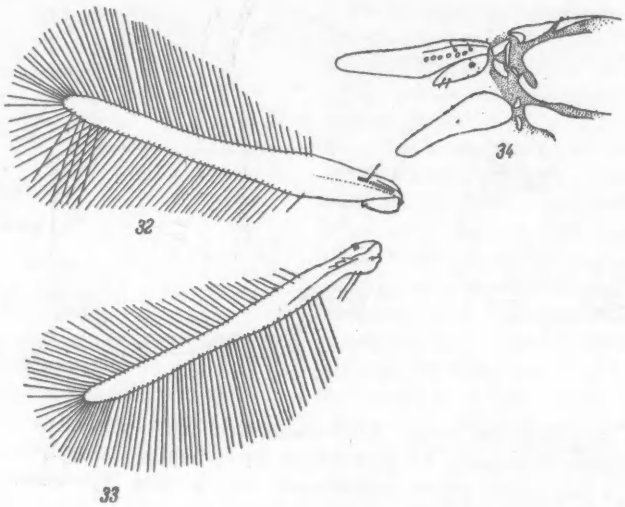


Fig. 31. H. yuccae. Sav., thoracic section from the side. aneps – Supraepisternum; anepm – superepimeron; katepm – subepimeron; msn – mesonotum; mtn – metanotum; pls – pleural suture; sp – spiracle. Other symbols as in Figs. 28-30.

The bristles on the edge of the wing begin receding 0.23 mm from the base, and at their origins they are somewhat sunken into the wing membrane, being completely rigid. At the distal end of the inner edge of the forewings the bristles emerge from the wing in a different direction, intersecting the other cilia, and are called supplementary cilia; they are 4-6 in number. On the forewings only a short basal arm of the longitudinal vein is retained, not reaching even half way along the wing. The hindwings are narrower than the forewings, their venation being simplified still further.

The structure of the legs differs from that of the larva and nymph. They are well developed both in the

male and female and have no secondary sexual characters. Each consists of coxa, trochanter, femur, tibia and a 2-jointed tarsus. The coxae are small and conical, those of the middle legs being smaller and set rather wider apart than the other two. Trochanter small, cylindrical, femur as long as tibia but broader than the latter, especially in the forelegs. The tibia are not dilated, longer in the hindleg than in the fore- or middle legs. Tarsus clearly separated, two jointed. The distal segment of the tarsus is very complicated and bears two unequal claws, between which are the vesicles characteristic of thrips and appearing to be modified empodia. The claws of the foretarsus are weakly developed; the tibia and femur are covered with regular rows of small bristles.



Figs. 32-34. H. yuccae Sav. 32) Forewings; 33) hindwings; 34) undeveloped wings.

The abdomen in both sexes is elongated and cylindrical and gradually tapers to the end, consisting of nine well-developed segments and the rudiment of the 11th segment in the shape of a small round lobe. As a rule, each segment consists of a rather large, convex tergite and a similar sternite. The abdominal pleurae are reduced to narrow creases between sternite and tergite.

The 1st abdominal segment in the male and female is atypical; the 1st abdominal tergite is almost completely reduced and is represented by five sclerites arranged in the membrane laterally in twos and a large one medially. The spiracles of the 1st abdominal segment are placed on one of the lateral sclerites of the tergum. The 1st abdominal sternite is very small and weakly sclerotized.

The 2nd-8th abdominal segments are typical and alike in both sexes; their tergites have raised edges and the bristles at the posterior angles of each segment are longer than the others; on the 2nd-8th abdominal tergites the medial bristles are curved and arranged in two longitudinal rows serving for holding the wings when in a state of rest. The 8th tergite has two pairs of bristles on the posterior edge. On the sides of the 8th segment is a pair of spiracles. The 2nd-8th abdominal sternites are well developed and moderately sclerotized. The 2nd abdominal sternite carries a pair of bristles on the posterior edge; on 3rd-8th are four pairs of bristles; on the 8th segment there is one pair of bristles in the female and three pairs in the male.

In the structure of the 9th abdominal segment and part of the 10th, differences are observed connected with the location of the sexual apparatus. In the male the 9th abdominal tergite envelops the 10th segment from above and on the side, and a narrow strip runs on to the abdominal wall. The strip on the anterior portion is not detached from the sternite and is called the coxal lobe;* a pair of bristles (0.53 mm long) are

*According to the terminology of De Gryse and Treherne (1924) the 9th sternite is called the subgenital valve; the lateral strip is the coxal lobe but its posterior branch, resembling claspers, are the coxites; according to the terminology of Snodgrass (1935) the 9th sternite is called the hypandrium but the lateral lobes are the distolateral branches of the 9th sternite.

situated on it. On the 9th abdominal tergite there are five pairs of bristles; the medial ones are longer reaching two-thirds the length of the 10th segment (0.46 mm long). On the 9th abdominal sternite of the male are two pairs of bristles, one straight and 0.3 mm long, the other curved. The 10th and 11th tergites are fused as in all other Tubulifera, the fused segments, together with the 10th sternite, form the apex of a tube. The posterior edge of the 9th sternite and the anterior edge of the apex of the tube have grooves which form an opening – the orifice of the copulatory apparatus (Fig. 22).

The sexual apparatus of the male is situated inside the 9th segment and consists of a weakly sclerotized, branched structure between the arms of which the aedeagus is placed (Fig. 35). At the base of this sclerotized structure is the basal plate [according to Priesner (1928 , 43-46), Basalstück] having the shape of a half-moon with a truncated end and appearing to be a rudimentary periandroconia (Figs. 35-37, pe)*. The latter joins a pair of short, lobe-like plates – the parameres (Figs. 35, 37, pm) **–on the tops of which are found two bristles. There is a further, long, sclerotized structure called the navicula (Priesner, 1956)*** which consists of a much shorter lateral part and a much longer median part which has a blunt end (Figs. 35, 37). The navicula is hollow and inside, in a retracted position, is the aedeagus which is capable of being evaginated; at the same time a membranous vesicle is expanded (Fig. 36, epph) – the epiphallus– at the end of which is a sclerotized, bifurcated, spoon-shaped organ (pseudovirga) bearing an opening at its tip leading to a canal (Fig. 36, epph, psvi, duej).

The comparative morphology of the male generative apparatus has not been sufficiently studied. Works published during recent years (Priesner, 1950, 1956; Ananthakrishnan, 1953; Mukerji and Jotwani, 1955) indicate that the shape and bristle armature of the 9th and 10th tergites, the shape of the coxal lobe of the 9th sternite and the structure of the sexual apparatus have a great importance in taxonomy.

The 9th abdominal tergite of the female, in contrast to that of the amale, does not enter the sternal area and does not close round the base of the 10th segment. On its posterior edge are situated six pairs of bristles of which the inner laterals and two pairs of median bristles are longer, reaching two thirds the length of the 10th segment. The sternite is divided by the genital cleft and represents, therefore, two plates.

In well-cleared preparations the interior chitinous keel – the fuscus (Fig. 21)– is seen as well as two curved spines placed on the 8th and 9th segments. On the ventral side in the female the apical tube (10th segment) has a straight base; thus, the external sexual organ is absent.

The rudiment of the 11th segment has ten bristles above, nine below. On the posterior angle of each sternite is a long bristle.

The difference between male and female is not strongly pronounced. The male is smaller than the female, well proportioned, the principal distinguishing characters being the difference in the chaetotaxy of the 8th and 9th abdominal sternites and also the differences in structure of the 9th and part of the 10th abdominal segments.

The chaetotaxy of the thorax and abdomen of the postembryonic stages in the development of the yucca thrips is given in Tables 4, 5 and 6.

As is seen in Table 4, in the arrangement on the thoracic segments during the posembryonic development of the yucca thrips, the following law was observed: the pronotum has more bristles in the nymphal stage (12-14), the mesonotum and metanotum in larvae I and II and in the pronymph (6); the number of bristles on the mesonotum and metanotum in nymphs I and II diminishes by two; the prosternum in all stages is devoid of

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*According to the terminology adopted by us (Priesner, 1956); according to De Gryse and Treherne (1924) this is the paramere; according to Ananthakrishnan (1953) it is the hypandrium.

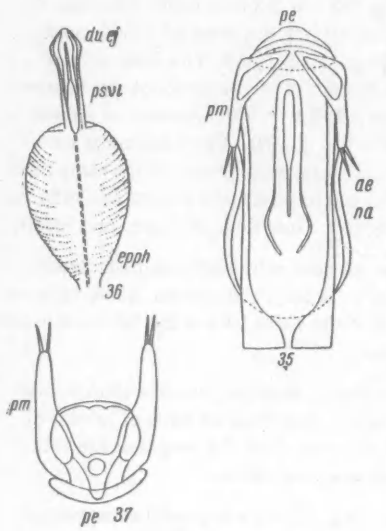
**De Gryse and Treherne (1924) under the term 'parameres' considered the proper parameres and periandroconia together. Priesner (1928) divides this structure into 'Basalstück' and parameres; he retains the latter term in his latest work (1956). According to Snodgrass (1935), Mukerji and Jotwani (1955) it is the apodeme.

***The same structure is considered as the hypophallus (De Gryse and Treherne 1924; Mukerji and Jotwani, 1955), harpogoner (Snodgrass, 1935), gonoforceps (Ananthakrishnan, 1953).

bristles; the mesosternum and metasternum carry the greatest number of bristles – four; the nymphs I and II and imago have only two bristles.

Tables 5 and 6 give pictures of the chaetotaxy of the abdominal segments in all stages of development of the yucca thrips.

From Table 5 it is seen that the chaetotaxy of the tergites of the 1st-8th abdominal segments in the larval and nymphal stages does not change, except that chaetae, which are absent in the preceding stages, appear in nymph II. On the 8th, 9th and 10th tergites the number of bristles increase in the successive stages; thus, on each of the 8th and 9th tergites two secondary bristles appear in larva II; on the 10th four secondary bristles appear in the pronymph; a similar number is retained in the following stages up to the imago except that on the 8th tergite in nymph III appear two more bristles. The chaetotaxy of the abdominal tergites of the imago differs strongly from that in the larva and nymph – the number of bristles in the adult insect increases, their arrangement is different and bristles serving for holding the wings appear.



Figs. 35-37. H. yuccae Sav., male. 35) Sexual apparatus; 36) aedeagus; 37) peri- and roconia, paramere; ae – aedeagus; duej - ductus ejaculatorius; epph – epiphallus; na – navicula; pe – periandroconia, pm – paramere; psvi – pseudovirga.

The chaetotaxy of the abdominal sternites is shown in Table 6, from which it is seen how the number of bristles on the sternites gradually increases from the early stages to the later ones. If in larva I there is only one pair of bristles on the 2nd-7th sternites, so in larva II one pair is retained, but beginning with the 3rd up to the 8th sternite a further pair of secondary bristles appear which was found already in the pronymph on the 2nd sternite. The same number of bristles is retained on these sternites up to pronymph II in which another pair of bristles appear on all sternites except the 10th. In the imago the number of bristles on the 3rd-8th sternites again increases by two. One should notice the sharp difference in the number of bristles on the 8th and 9th sternites in the male and female. If there are six bristles on the 8th sternite and four on the 9th sternite of the female, so in the male there are only two on the 8th and none on the 9th. It is considered that this character is one of sexual dimorphism.

Thus, in the process of postembryonic development of the yucca thrips the chaetotaxy of the thorax and abdomen undergoes changes, the greatest of which are in the thoracic tergites and abdominal sternites.

SUMMARY

The development of Haplothrips yuccae Sav. under the conditions prevailing on the south coast of Crimea was investigated. The article comprises a detailed description of all the developmental phases. H. yuccae hitherto has never been recorded as occurring in Crimea. Its host plants are the different species of yucca exclusively, large populations being found in leaf axils. Five molts were observed during the postembryonic development, there being two larval and three nymphal instars. The duration of all the developmental phases and instars is shown in Table 1. The principal characters by which the instars were distinguished were the length and the width of the head, of the antennal joints, of the prothorax, of the 9th and 10th abdominal segments, the length of the temporal bristles, of the postangular bristles on the prothorax, of the terminal bristles of the 11th abdominal segment and of the postocular bristles (for the nymphal instars). The dimensions of the antennal joints and the number of bristles thereon are shown in Tables 2, 3 and 7. The chaetotaxy of the thorax and abdomen of all the developmental phases is summarized in Tables 4, 5 and 6.

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THE BIOLOGICAL BASIS OF PHYLLOXERA (DACTYLOSPHAERA VITIFOLII SCHIM., HOMOPTERA, PHYLLOXERIDAE) CONTROL

S. M. Federov

I. Introduction

The year 1954 marks the centenary of the discovery of the vine phyldoxera, among wild grape vines in the Mississippi basin region of North America. This insect was brought to Europe sometime during the last century and quickly spread throughout European vineyards, where it became a serious pest of viticulutre. In all countries of the world this pest is now an object of research. A close study of phylloxera has been made by French scientists (Planchon, Lichtenstein, Balbiani, Boiteau, Cornu Maillet, etc.) by Italian scientists (Grassi, Foa, Grandori, Toppi, etc.) and by the Germans Moritz, Börner, Devitz, Stellwaag, etc. Phylloxera has been studied in Switzerland by Schneider-Orel, Feiss, Leitzinger and others. In Russia, the present research on phylloxera was initiated by Krasil'shchik, A. O. Kovalevskii, Mokrzhetskii, Silant'ev, Porchenskii, Shevyrev and others. In the USSR the All-Union Conference on Viticulutre held in February 1926, stressed the need for a study of this pest and the Soviet People's Comissar passed a resolution, according to which the following stations for phylloxera research should be set up: Tuapse (Vodinskii station), Tiflis (Mordvilko), Odessa (Vasil'ev), Teleani and Georgia (Kalandadzhe and Aleksidze), Armenia (Grdzelyan) and at Gryunfeld' in Azerbaidzhan (Kozhanchikov). As a result of the study of phylloxera the Sluzhbe quarantine was enforced. Phylloxera has also been studied in certain institutes devoted to viticulture (Prints, Aleksidze Fedorov and others). Finally, at the present time, the biology of phylloxera is being studied at the Ministry of Agriculture's Anti-Phylloxera Scientific Research Station in the USSR.

It is necessary to record that the morphology and anatomy of this polymorphic insect are already well known. A certain amount is also known about its physiology. It has been established, for example, that phylloxera is strictly monophagous, feeding only on vines of the genus Vitis and not attacking species belonging to other genera of the vine family. Different research workers have interpreted the biology of phylloxera in different ways and in consequence there is no uniform picture of the life cycle of this pest or of the best method for controlling it. It must be confessed that all the proposed methods of control have proved to be ineffective and have failed to eliminate phylloxera from any part of its range. This fact is excellent justification for the view that contemporary theories regarding the phylloxera problem do not lay sufficient emphasis on its biology. There are special difficulties attached to the study of this insect, which result from its way of life in the soil, its seasonal changes in form, its seasonal migrations, its various relationships with different species and varieties of food plants and finally its small size. Because of these difficulties, specialized techniques and equipment for both field and laboratory investigations are needed in phylloxera research.

My own views on the biology of phylloxera are at variance with those of many other specialists who have not made a thorough investigation of this species, but have uncritically and without foundation based their conclusions on the work of foreign investigators. Many of the biological phenomena regarding this species have so far received no explanation or have been given contradictory explanations. The division of the parthenogenetic wingless females into two forms (the form of leaves, gallicolae, and on roots, radicicolae); the presence of nymphs in the galls; the bisexual generation of wingless forms; the "direct gallicolae"; the leaving of roots by wingless virginoparae, and their emergence from the soil to form galls on the leaves; the emergence of nymphs from the winter eggs of the sexuales; the transfer of phylloxera from aerial parts of vines to the subterranean parts which occur in both summer and autumn – all these are facts left unexplained by the theories

of foreign scientists. It is difficult, at the present time, to give a true picture of the developmental cycle of phylloxera as the research work relating to it is not finished. However, in this present paper, we are attempting to summarize, to some extent, studies which have been made on phylloxera.

II. The Systematic Position of Phylloxera

The vine phylloxera, in contemporary systematics, is assigned to the family Phiioxeridae.

On the basis of priority, phylloxera is now given the scientific name Dactylosphaera vitifolii Schimer. The contemporary systematics of phylloxera is dealt with in a paper by the German aphidologist Börner (Börner, 1930).

Shaposhnikov (1950) dealing with the system of aphid classification proposed by Börner, rightly states that in it the formal morphological method predominates, a method which permits of a considerable amount of subjective judgment, and he goes on to say that the use of this method has led Börner to draw a good many erroneous conclusions. That Börner placed the gall-forming aphids at the top of the phylogenetic tree, although they show many primitive features, is a case in point. Many phylloxera have lost the multifaceted eye, the proboscis in the sexual forms, the anal aperture in all stages, certain veins on the wings, segments of the antennae, etc. However, these losses are not secondary phenomena but may be considered as adaptations to a parasitic mode of life. It is obviously necessary to consider phylloxera as an endoparasite, since it lives in galls or in nodules. Adaptation to a parasitic mode of life is not a progressive, but a regressive phenomenon. There is no doubt that the loss of certain organs in the vine phylloxera as a result of its parasitic life is beneficial to the organism, which therefore, in general,does not show such a high level of organization as do the more advanced aphids. In the vine phylloxera there is no vivipary,nor Malpighian tubules, caudal filament and other morphological features, which could be regarded as secondary and collectively would denote real phylogenetic progression. This testifies to the fact that the vine phylloxera is a primitive aphid.

III. Polymorphism of Phylloxera

The vine phylloxera, like all aphids, is a polymorphic species and in its life cycle there are encountered individuals, which differ in outward form and internal organization and even in their way of life. Five principal forms may be distinguished in the life cycle as follows: 1) wingless forms on leaves – aptera gallicola, 2) wingless forms on roots – aptera radicicola, 3) nymphs, 4) winged sexuparae – alatae and 5) sexual forms, male and female – sexuales. The majority of research workers distinguish two types of individuals among the wingless, parthenogenetic females, which emerge from the eggs laid by the sexuales and which they call fundatrices. Many investigators have found larvae which are of an intermediate type between the gallicolae and the radicicolae, and among the nymphs, wide-bodied oval, elongate forms, termed "nymphales"; finally among the alatae, they recognize two forms in which they wish to see the sexuparae and sessuales, as in other aphids.

During the period of my acquaintance with phylloxera in the Black Sea coastal area and my study of it in Transcaucasia and Ukraine, I have carried out a series of experiment and observations on polymorphism in phylloxera, the results of which form the basis of the following account.

Every specialist on phylloxera stresses the fact that the wingless gallicolae differ sharply from the wingless radicicolae in the length of the proboscis stylets, the presence of tubercles on the scutum of the radicicolae and the presence of knobbed setae on the tarsi of the gallicolae.

According to my own observations, all these features are ill-defined and extremely variable.

The measurements which I made on the sexuales (using Börners method) show that among the individuals of the first generation from galls, the stylets vary in length from 122 to 240 microns and that it is very difficult

*Mordvilko states that the vine phylloxera can transfer itself from the vine to the American hickory (Carya), on which another species of phylloxera – Phylloxera perniciosa Perg. has previously been found to occur. According to the research of Pergande, the annual cycle of this latter species is represented by three forms. From eggs laid by sexuales on roots, the fundatrices emerge which give rise to galls on the leaves and petioles; from eggs layed by these emerge the winged sexuparae. The latter lay eggs of two sizes – the larger giving rise to females and the smaller to males. The females of the sexual form, after impregnation, lay "winter" eggs. These facts compelled us to pay attention to the polymorphism in the vine phylloxera.

to find any regularity in their variability. Grandor, investigating the limits of possible variation among the barbed stylets found that in the first generation of gallicolae, their length varied from 122 to 163 microns and in the second generation of radicicolae they usually attained a length of 122 microns, only among individuals of the following generation did they reach 190 microns. Kozhanchikov, investigating the length of the stylets in the wingless radicicolae found that it varied according to the age of the individual, seasonal polymorphism, nature of feeding, etc. From all this, there appears to be good grounds for assuming that the length of the stylets is a characteristic of little diagnostic value.

Even more variable as a diagnostic feature are the ridges on the scutum, which are supposed to occur in radicicolae and be absent from gallicolae. The occurrence of these ridges has been noticed in the wrinkling of the cuticle in all forms. We consider them to be an ecological adaptation among the radicicolae, inconstant in number and form. In our experiments, we took young larvae which were already sucking the sap on the roots and by disturbing them compelled them to withdraw their probosces and transferred them to galls on the leaves, where they develop as forms with smooth integuments. The third feature, i.e., the knobbed setae on the tarsi is an extremely variable one and is characteristic of all forms of phylloxera which occur on leaves.

Thus, there are no stable, morphological characteristics which can be used to distinguish between the apterae gallicolae and the apterae radicicolae. They all have a wide and somewhat clumsily built body 1.25-1.5 mm in the length and 1.0 mm wide, which is indistinctly divided into head, thorax and abdomen. The head possesses a sucking mouth composed of a proboscis sheath formed from the labium and four piercing stylets, corresponding to the maxillae and mandibles. The antennae are three-jointed with a single olfactory pit – the rhinarium. The eyes consist of three facets. In the wingless, adult forms there is a rudimentary gonapophysial apparatus on the abdomen. Among the peculiarities of their internal anatomy should be noted the closed intestinal tract, the absence of Malpighian tubules, and the strong development of the salivary glands, features which occur in other forms of phylloxera. This type of organization is linked with the extraintestinal digestion which is observed in phylloxera and explains the absence of the anal aperture and the excretory organs.

The reproductive organs of the apterae consist of two series of ovarian tubules with from one to seven members in each series. The tubules begin as terminal vesicles and lead into compartments which form the paired oviducts, the latter joining to form an unpaired oviduct which in turn leads into the uterine bursa. Paired glands discharge their secretions into the bursa.

Investigations into the bionomics of the apterae show that they can migrate from the leaves to the roots and vice versa, from the roots to the leaves, where they produce the galls, capable of growth until the end of the season. In the galls, we found many females, nymphs and alatae, which did not differ in any way from those occurring on the roots. We therefore consider the apterae gallicolae and the apterae radicicolae to be identical forms. To distinguish the one form from the other is impossible on both morphological and biological grounds. The presence of migratory forms (on the shoots and elsewhere) merely confirms this view. Thus, there is a single basic form – the aptera. Among the nymphs, research workers have for a long time distinguished wide-bodied, oval and elongate forms but the characteristic body form is an inadequate feature for separating them as they are all really modifications of a single type, their shape being caused by their particular habitat (in galls, or in slender or thick roots). The nymphs inevitably give rise to winged forms (alatae).

The alatae are up to one millimeter in length and have their bodies clearly separated into head, thorax and abdomen. The head bears a pair of three-jointed antennae and on the third joint there are two olfactory pits – rhinaria, one at its base, the other at its apex. The eyes are of three types: lateral, larval three-faceted eyes, miltifaceted, adult eyes and simple unfaceted ocelli. The mesothorax has a pair of large wings and the metathorax a pair of small wings. Their gonads are similar to those of the apterae.

Finally, the third basic form is represented by the sexuales. These result from eggs, from which larvae have emerged and passed through four instars, each lasting four to six days. The adult sexuales lose the proboscis and do not feed. Compared with the other forms the sexuales are very small. The males are 0.28 mm long and 0.18 mm wide and the females, though somewhat larger are only 0.48 mm long and 0.21 mm wide.

In addition, to these basic forms, there are ocassionally found on the roots, individuals of the form nymphales, which appear to be intermediate in shape and characteristics between the alatae and apterae females. Such individuals possess eyes with more than three facets, they have ocelli and antennae like those of the alatae and wings like those of nymphs. This form occurs only ocassionally.

In this way, our research has revealed the life cycle of the vine phylloxera to consist of the following three basic forms: 1) the virginopara aptera form (represented by fundatrices, gallicolae and radicicolae), 2) the sexupara alata form (represented by the winged nymphs) and 3) the sexualis form (represented by the males and females).

The three basic forms in the life cycle of the vine phylloxera may be distinguished by their eggs: the first form (virginoparae apterae) lays eggs of uniform size (0.25-0.30 mm in length by 0.15-0.20 mm in width) with a smooth chorion; the second form (sexuparae alatae) lays eggs of two distinct sizes (the larger giving females being 0.32-0.38 mm by 0.16-0.17 and the smaller giving males 0.25-0.27 by 0.13-0.15), all having a reticulate chorion; the third form (sexuales) lays eggs of uniform size (0.27 by 0.14 mm) with a reticulate chorion and an appendage which resembles a limb or supporting structure. The determination of all these forms of the vine phylloxera leads to a better understanding of the life cycle, which in my view is a good deal simpler than that described by Grasi and Börner.

IV. Parthogenesis

According to the older literature, the vine phylloxera develops differently on American vines than it does on European vines. On the European vines it lives predominantly on the roots, where it reproduces parthenogenetically. Boiteaux in six years obtained twenty-five generations in this way and Börner in eight years obtained sixty-seven generations. The observations of these research workers lead one to suppose that the vine phylloxera, particularly on the roots of European vines, exists for a very long time and possibly for ever, as a parthenogenetic form. In order to investigate the problem of parthenogenesis we conducted the following experiment. Overwintering wingless females on vine roots were isolated in wide glass tubes, closed at the end with cotton wool, and were left in them in order that the fate of the colony might be observed. We noticed that all the members of the colony ultimately changed into nymphs and after that into winged forms. The experiment was carried out several times. Other workers have performed similar experiments and have obtained the same results. From this, it may be concluded that the parthenogenesis of the vine phylloxera in nature is not lengthy in duration but merely lasts for one season, as in the majority of aphid species. Normal sexual reproduction may be considered as an integral part of the life cycle of phylloxera for the number of ovipositions made by parthenogenetically reproducing females diminishes with successive generations and only after copulation does the number increase. This fact illustrates admirably the biological insufficiency of parthenogenesis in phylloxera. Nobody can deny the biological importance of fertilization in bringing about a combination of hereditary factors from two different sources and thus favoring increased vitality in the organism as a whole and a greater possibility of its adaptation to the varied conditions of life.

V. Bionomics and Life Cycle

Phylloxera appears on the roots of plants in different forms. These forms arise and follow one another in known sequence according to definite ecological conditions. The regular succession of one form after another constitutes the typical developmental cycle for this species.

The life cycle of the vine phylloxera has been studied by many investigators. The most comprehensive schemes for the phylloxera life cycle are those of the Italian scholar Grassi and the German Börner.

Grassi's scheme (Fig. 1) shows the most complete life cycle as carried out on vines of American origin. The "winter eggs" which are deposited by impregnated females under the roots of the vine, give rise to the "fundatrices". These migrate to the upper surface of American vine leaves, where they pierce the epidermis and form galls. Eggs are deposited in the galls and from them develop wingless parthenogenetic forms (virginoparae apterae); in the course of the season many generations of such virginoparae may be produced. As the season goes on, more and more of the virginoparae apterae quit the leaves for the roots of the vines,. On the roots, these forms may go on producing generations of wingless, parthenogenetic individuals for a long time. Many of their larvae, after the third ecdysis, can turn into nymphs and ultimately give rise to winged adults. The latter emerge on to the surface of the soil and ascend to the leaves of American vines, where they lay their eggs, of two kinds – a small form which produces males and a larger form producing females. The sexual forms (sexuales) lay a single egg, which overwinters and in spring hatches to give the fundatrix. On European vines, phylloxera passes through a simplified version of this life cycle and gives neither "winter eggs" nor

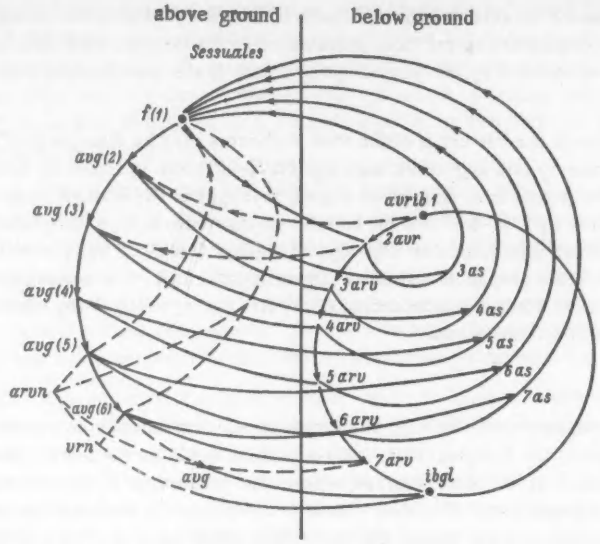

Fig. 1. Life cycle of vine phylloxera according to Grassi, 1912. (1) f – Fundatrix; (2) vg – virginoparae gallicolae; arvn and vrn – generations, giving nymphs and gallicolae alatae; avrib – virginoparae which overwinter on the roots; ibgl – virginoparae radicicolae which have come out of hibernation; 2avr-7avr – virginoparae radicicolae; 3as-7as – nymphs on roots which give the alatae; sessuales – alatae. Vertical line divides the subterranean from the aerial generations.

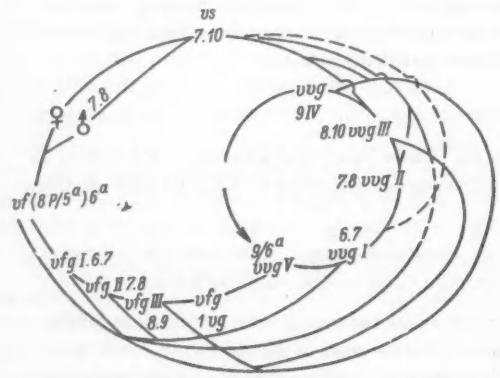

Fig. 2. Life cycle of phylloxera after Börner 1930. vf – Fundatrix; vfg – generations on leaves; vvg – generations on roots; vs – alatae.

"leaf forms" and consequently the latter cannot migrate directly onto the roots of European vines. Grassi's scheme shows the presence of galls on European vines, the occurresnce of winged forms, the migration of radicicolae larvae to the leaves (primary gallicolae), etc., but these phenomena may be regarded as rare and atypical.

Börner (Fig. 2) accepting Grassi's scheme in its entirety, emphasizes to an even greater extent the differences between phylloxera developing on the roots and those forms developing on leaves; the first he terms "Virginogenien". Generation after generation of these forms may follow each other on the roots, according to him.

He goes on to say, that in the south the radicicolae apterae sometimes produce nymphs, which give rise to alatae. The latter leave the soil and migrate to the aerial parts of the vines (particularly the American vines), where they lay eggs of two kinds – a small form which gives rise to males and a larger, giving females. After impreganation the females among the sexuales lay a single "winter egg", from which the fundatrix emerges in spring and gives rise to several generations of gall formers (Neogallicolen-Gallicolen – Fundatrigenien). Their sisters (Neogallicolen-Radicicolen) give rise to parthenogenetic, root forms (Virginogenien).

The effects of phylloxera on various species of the genus Vitis has been a subject of research for many investigators (including Börner) and they have demonstrated the presence of races, biotypes, phenotypes, etc., in this species.

From what has been stated above, it follows that within the developmental history of the vine phylloxera it is possible to recognize two cycles; one – the complete cycle, which includes the parthenogenetic reproduction of the radicicolae, the development of the sexual forms and the emergence of the fundatrices, whereby, the transfer back to the roots is accomplished; the other – is incomplete, only embracing the parthenogenetic development of radicicolae. The first cycle is usually characteristic of the south, where climatic conditions are favorable and this cycle takes place on both American vines and their hybrids. The second cycle is more characteristic of the European types of vine.

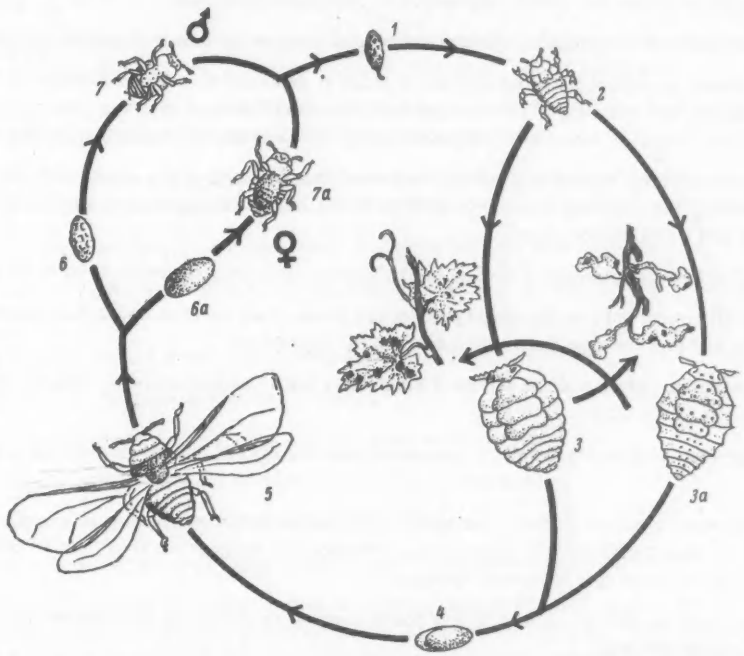

Fig. 3. Developmental cycle of the vine phylloxera, after the author. 1) "Winter egg"; 2) undatrix; 3) virginipara aptera; 4) egg of virginipara aptera; 5) egg of sexupara which will give a male; 6) egg of sexupara which will give a female; 7) male sexualis; 8) female sexualis.

On the basis of our own observations on the vine phylloxera (Fig. 3), which were carried out in Transcaucasia, along the Black Sea coast of Caucasia and in the vineyards of the Ukraine, we consider that the species overwinters as the first and second instar larvae of the wingless parthenogenetic females (both radicicolae and gallicolae) and also as the larva which emerges from eggs of the sexuales in autumn. All these forms have different reproductive potentialities. After overwintering these larvae emerge in the spring and settle down either on the roots or if climatic conditions are favorable they leave the roots and migrate to the aerial parts of the plant. Subsequently, there results a series (8-10) of generations of wingless virginoparae in galls on leaves and roots, or on the roots only. Both on the roots and on the leaves, they produce numerous egg deposits, sometimes changing from roots to leaves or vice versa. As a rule, the virginoparae from eggs layed by the sexuales are most prolific, whereas the virginoparae from eggs layed by the radicicolae are much less so. Furthermore, the radicicolae lay fewer and fewer eggs as the season progresses. Nymphs make their appearance by the middle of summer (June-July) and sometimes earlier, both among the radicicolae and gallicolae. In the autumn, there is an increase in the number of nymphs. The alatae make their appearance early in the

season. After a short period of motility, the alatae lay their eggs on the leaves and shoots of the vine. From these eggs the sexuales emerge, they mate and lay their eggs on the two-year-old and more mature branches and stems of the vine. As a rule, eggs deposited by the sexuales do not overwinter, except in rare cases and under favorable conditions existing in the south Instead, these eggs give rise to virginoparae-fundatrices which migrate to the roots, where they spend the winter and in spring give a generation of parthenogentic, wingless individuals. These apterae are adapted to living both on roots and leaves and in the course of the season they give rise to the other principal forms: alatae, apterae and sexuales.

The life cycle of the vine phylloxera, as described above, takes place on all susceptibe vines of the genus Vitis, whether they are of European or American origin; however, in some vines, phylloxera is found mainly on the leaves and to some extent on the roots, on others the converse takes place, while among a third group roots and leaves are attacked to an equal extent. The sorts of vines which bear galls appear to suffer less from phylloxera on their roots than do those which lack galls. The vines which initially do not bear galls gradually come to do so as a result of a slow, but certain adpatation to phylloxera infection.

Our observations on the developmental cycle of the vine phylloxera lead us to stress the following points.

1) The development of phylloxera in the vegetative period is expressed as a series of generations consisting of wingless parthenogenetic females, which occur on both roots and leaves of the vine; during the first generation an abundance of eggs is laid, but the number of eggs drops gradually in subsequent generations.

2) Nymphs first make their appearance among the second generation of virginoparae, both on the roots and in galls on the leaves; they increase in numbers throughout the subsequent generations so that they are present over a period of three or four months or more.

3) Alatae may be found from June (or earlier) until October; they may be encountered in all generations.

4) Sexuales usually occur only on the aerial parts of old vines; they begin to appear in summer, persist throughout the autumn and produce eggs from which develop the fundatrices.

5) Only the fundatrices larvae and the larvae of potentially fertile parthenogenetic virginoparae are able to overwinter on the roots of the vine.

6) The development cycle of phylloxera, as measured from the eggs of one sexuales to the nest, lasts about a year.

7) The developmental cycle of virginoparae apterae terminates with the formation of nymphs, alatae or sexuales. The last of these are in the vine phylloxera, a "biological vestige" but they from an obligatory link in the complete life cycle of this holocyclic species.

Our observations indicate that the following four points need to be considered in formulating practical control measures against phylloxera.

1) A single winged individual (sexupara) can initiate the infection of the vine and its progeny will include members of both sexes.

2) The winged individuals (sexuparae) are dangerous both for American and European varieties of vine, as they are able to produce the sexuales and thus initiate the infection.

3) Phylloxera develops parthenogenetically on the roots throughout the season and inevitably gives rise to nymphs, sexuparae alatae and sexuals, both on European and American sorts of vine.

4) The eggs of the sexuales are unable to overwinter, except occassionally in the south; they give rise to the fundatrices in summer or autumn, and it is this latter form which overwinters on the roots and in spring gives rise to a series of parthenogenetic generations on both roots and leaves.

Thus, all forms of phylloxera are potentially dangerous as disseminators of infection among European vines. Consequently, a practical system of controlling this pest must aim at eliminating all its forms and not just the virginoparae on the roots.

VI. Phylloxera Resistance and Its Causes

Resistance to phylloxera is a very important property of certain vines. The belief is widely held that American sorts and varieties of vines are resistant to phylloxera attack, whereas European types have no such

resistance and are highly susceptible to this pest. The true state of affairs is, however, somewhat different. It must be stated from the outset that all varieties of cultivated vine belonging to genus Vitis have originated from the one species, V. rotundifolia and are in some measure susceptible to attack by phylloxera, both on their aerial and their subterranean parts. Alongside this, it must be noted, that vines on which phylloxera attacks the leaves have a high resistance to root infection by the pest and vice versa. Root infections are considered more important and are more destructive to the vines themselves than are leaf infections. The latter are often treated as a sign of resistance against root infection.

According to Aleksidze, 1948, on the basis of his experiments using "leaf" froms of phylloxera, which were carried out in Uriatuban (Georgia), it is possible to divide all varieties of grape vines into the following five groups:

First group (with many large galls containing egg chambers) comprises such Georgian varieties as "Bueri tetri" and "Chinuri".

Second group (with many small galls containing egg chambers), comprises twelve Georgian varieties, the European variety "Bastardo" and the American varieties "Lemanto" and "Captivator".

Third group (with few galls and with relatively few egg chambers) comprises six Georgian varieties, the European variety "Yellow Kishmish" and the American variety "Beck".

Fourth group (with few galls, all of them false galls without egg chambers), comprises five Georgian varieties, seven European varieties and the American varieties "Isabella-Fromelia" and "Isabella".

Fifth group (with only phylloxera punctures) comprises five Georgian varieties.

In addition, his experiments with American, Franco-American grafted vines and ungrafted varieties gave the following results:

First group – Comprised about twenty grafted sorts and two ungrafted.

Second group – comprised two grafted varieties.

Third group – comprised five grafted varieties and two nongrafted.

Fourth group – comprised eight grafted varieties and one nongrafted.

Fifth group – comprised one grafted variety "Rupestris du-Leau".

Varieties of vine without phylloxera punctures on the leaves are not shown in the lists.

From these experiments the author arrived at the valid conclusion, that phylloxera will attempt to feed on all kinds of vines and only abandon the attempt in such cases where it is unable to utilize the sap from the leaf tissue. When the fruit stalks of vines were infected by phylloxera – derived both from the leaves and later from the roots – the results obtained confirmed those of the previous experiments and showed that the varieties of vine used in the tests reacted equally to both the root form and the leaf form of phylloxera. Moreover, it was noted that in nature the number of galls on different kinds of vine depended on the conditions in which the phylloxera developed during its vegetative phase of the previous year and on the composition of the leaves: the phylloxera developed and produced galls on young leaves, but did not attack the old ones. Among the varieties attacked were American grafted vines, nongrafted vines, and European sorts all of which showed the same degree of susceptibility to phylloxera attack. In this context it should be mentioned that the first galls to be observed on the vines of France occurred on the European variety "Tinto"; in Italy, the European variety "Barbara" is particularly prone to severe attack by the leaf-form of phylloxera, and in southern Ukraine (Odessa) phylloxera galls cover the leaves of the variety "Sereksiya", and quite frequently those of "Shasla belaya" and almost all varieties in nurseries.

Kostik in 1955 studied the development of phylloxera on the leaves of European varieties of vines in Moldavia and came to the conclusion that phylloxera requires the existence of certain well-known physico-chemical conditions in the host tissues e.g., hydration, turgor pressure and viscosity, and only when these conditions are fulfilled will normal galls be produced on the leaves.

The causes of phylloxera resistance in vines have been characterized quite clearly by Zotov in 1955.

He pointed out that in order for phylloxera to feed it was necessary for certain simple, slightly soluble organic substances - sugar, amino acids, etc.- to be present in the sap. In addition to these substances, the tissues of the vine consist of complex organic materials, which phylloxera cannot assimilate. In order, therefore, to prevent the formation of these complex materials, phylloxera introduces hydrolytic enzymes into the vine sap which favors the accumulation of the simpler substances. Phylloxera-resistance in vines may be considered as the ability, possessed by the cells of certain vines, to overcome the effect of the phylloxera enzymes and thus these vines continue to synthesize complex organic substances even when they are attacked. As a result of this, the metabolism of their infected parts is completely unaffected or only slightly affected by the presence of phylloxera. Such a contrast between the reaction of the resistant and the nonresistant varieties is conditioned by the various morphological, anatomical and cytological peculiarities of the tissues of different vines. The practice of viticulture testifies to the irrefutable fact that a few vines belonging to different varieties will survive on their own roots even when exposed to severe phylloxera infection, under the conditions prevailing in Transcaucasia, Moldavia, the Ukraine and in other places. Zotov, who used various phylloxera-resistant and nonresistant sorts, demonstrates how the method of clonal selection used on European phylloxera-resistant vines may increase their resistance.

VII. Methods of Phylloxera Control

Phylloxera was brought into Europe during the second half of the nineteenth century. In 1863, it was discovered in a greenhouse near London by Westwood. About this time, it was noticed as a destructive agent in French vineyards where Planchon described it in 1868. From that time, the search for methods of controlling the pest has continued without ceasing. During the first five years following its discovery hundreds of control measures were formulated and the greater part of them were put into practice. All of them have proved to be useless. This is largely due to the fact that their formulators attempted to destroy phylloxera without first making a detailed study of its biology. Because of this, the control measures which were devised possessed little suitability for the task and their application proved unprofitable.

All present-day techeniques of phylloxera control fall into the following three categories: preventative measures, combative and destructive measures and natural means of control. Among preventative measures a prominent part is played by quarantine (including the supervision of phylloxera infected foci, the disinfestation of imported material and the periodical inspection of vineyards; the destructive measures are the most fundamental and affective; whereas, natural measures of control include the planting of vines in noninfected soils, graftingculture, the planting of hybrid vines on their own roots and the use of indigenous phylloxera-resistant strains.

We shall attempt to give an appraisal of all these techniques in the light of contemporary knowledge regarding the biology of this pest.

Antiphylloxera quarantine was established in the USSR in 1935. The law relating to quarantine provided for a detailed division of the vine growing regions into districts, an order dealing with the treatment of infected material, an order relating to the establishment and registration of vineyards and provision for the destruction of phylloxera-infected centers. The aim and scope of this piece of legislation was extremely broad and was directed toward the recognition of phylloxera-infected centers, the destruction of the pest there and the isolation of infected areas from noninfected ones. The act also made supplementary provision for American vines and their hybrids in addition to European ones, on the basis of what was believed to be the greater vulnerability of the latter to winged forms of phylloxera.

The eradication of phylloxera by directly destroying it imposes severe losses on the part of the vinegrowers and can therefore be used only to a limited degree. It is best employed in those cases where the area of infection is very small. Modern chemical methods which destroy the pest, but not the roots of the plant however are replacing methods of destroying phylloxera which also entail the destruction of vine roots. The final resolution of this problem now occupies the attention of a large number of Soviet specialists. It is to regretted that the efforts of all these workers are directed toward the research for means of destroying phylloxera on the roots. Toxic substances have been found which when introduced into the soil at appropriate depths speedily and effectively kill phylloxera; unfortunately the application of such substances cannot readily be mechanized and therefore is only employed in practice on a limited scale. Moreover, it must be remembered that, in accordance with our findings, a single fumigation of the soil cannot free any vineyard of this pest, which lives not only on the

vine roots but is equally likely to be found on the aerial parts of all vines in the form of parthenogenetic females, winged sexuparae and sexuales. It is true that on European vines this occurs to a limited extent, but nevertheless it does so, on them as on American forms. The struggle to free vineyards from phylloxera must go on.

Our own researches suggest that any effective method of chemical control should utilize the technique of introducing a fumigant into the soil at a particular level, not more than 25-40 cm below the surface and then following this by treatment of the aerial part of the vine using spraying or washing techniques to destroy any gallicolae, sexuparae or sexuales. In the combination of a soil fumigant technique with washing and spraying of the foliage we see an effective means of control against the vine phylloxera. All control measures against phylloxera should be carried out in spring, summer and autumn.

The method of subsurface control consists of treating the soil in infected vineyards with small doses of fumigant; this treatment being repeated annually or at definite intervals. It is necessary to remember that this method does not destroy phylloxera completely. Any carelessness in application (e.g., laxity in time of repetition too low a dosage, too scattered injections of fumigant, inferior quality of fumigant) can result not melely in rendering the treatment useless but in making it dangerous, for all these defects may actually encourage the spread of infestation – as has occurred for example in Azerbaidzhan vineyards.

In using sand for vine culture it must be remembered that by no means all kinds of sandy soil are effective against phylloxera, but only those consisting of not less than 60-75% of quartz particles, having a water capacity of not more than 24-40% and being of known friability. In sand soils not conforming to these standards phylloxera can both live and cause damage to vines. In these latter soils and even in such antiphylloxera sands as our own Aleshkovskii sands phylloxera can live for several years (2-3) and vines planted in such soils only lose their infestation very slowly. Ignorance of this fact leads to disappointing consequences (Anapa).

Immune stock culture is based on the relative phylloxera resistance of American-American hybrids and American-European hybrids, used as stocks for European scions. It should be remembered that phylloxera resistance in any stock is a highly variable quality and may be conditioned by a particular soil, climate or relative virulence of the pest. Consequently, it is to be expected that among different regions where grapes are grown the effect of grafting onto "immune" stocks will vary; nowhere, however, is the protection afforded by this technique a permanent one as phylloxera can and will ultimately adapt itself to "immune" root stocks. We have found this to be the case in southern Ukraine where the majority of grafted varieties of vines which had been evolved with a view to stamping out phylloxera are now serious carriers of the pest. From all this it may be concluded that the generally accepted techniques of grafting onto "immune" stocks is not a really effective method of phylloxera control and can never be depended upon as a means of protecting our vineyards from this pest. Indeed, because it produces a temporary effect which is not however permanent this method may bring about a serious drop in long-term production, for it renders the restocking of vineyards with reliable varieties; an apparently less urgent task. This latter task must however be effected, by introducing hybrids growing on their own roots; we know, however, that in certain European countries there are laws against the breeding and distribution of such hybrids. It must be admitted that despite fifty-years work by selectionists, up till now, no strain of vine has been produced which is completely resistant to phylloxera and at the same time yields really high quality fruit. All nonhybrid vines give poorer quality fruit than do the European grafted varieties and, as they are all strongely infested with phylloxera, they serve as carriers of this pest.

At the present time opinions are being expressed in favor of planting nongrafted, high quality fruiting vines known to be partially phylloxera resistant, even in those areas where phylloxera occurs. Investigations carried out by the All-Union antiphylloxera research station of the Ministry of Agriculture USSR has shown that the high economic value of nongrafted vine culture depends upon the fulfillment of three fundamental conditions: correct choice of district, defense against phylloxera infection and a high standard of agrotechnical knowledge and skill.

In our opinion the best immediate and long-term methods of phylloxera control are 1) the planting of phylloxera-resistant European varieties obtained by clonal selection, 2) soil fumigation combined with spray treatment of the vine foliage. The first method ensures and maintains a high degree of resistance to phylloxera in our vines, while the second method creates conditions unfavorable for the existence of the pest. The employment of such methods should render it possible to succeed in protecting our vineyards from this pest.

SUMMARY

The existing methods of phylloxera control are inefficient and fail to suppress this pest to any considerable extent, to say nothing of its complete extermination. The cause of this lack of adequate methods of control is that the knowledge of the life history of this species is still quite vague.

Some foreigh authors* erroneously determine the taxonomic position of this species, as a gall-forming aphid at the top of the phylogenetic tree, whereas it is actually a primitive form.

According to the data obtained in this study, despite the existing view, not five, but only three forms can be distinguished in the life cycle of this species, differing in morphology and in the size of eggs. Fundatrix, aptera gallicola and aptera radicicola are classed as belonging to one form, virginopara aptera; the second form is sexupara alata and the third form is sexuales (male and female).

Parthenogenesis is never perpetual, but lasts only during the breeding season; it should be regarded as an adaptation of the life cycle to the conditions of existence of this species, the high mortality being thus compensated for by the intensification of propagation.

In the life cycle of D. vitifolii there are several parthenogenetic generations of virginoparae, both on leaves (gallicolae) and on roots (radicicolae). The fecundity of the first few generations is very high, decreasing gradually in subsequent generations. Suxuparae alatae are found from June (or, sometimes, still earlier) until October. Sexuales are usually found only on old shoots from the beginning of summer until autumn. Winter eggs usually hibernate, but sometimes fundatrices hatch from these eggs in summer and in autumn. These fundatrices, as well as the nymphs of fundatrices and those of potentially fertile virginoparae hibernate only on roots. The life cycle is annual. After a number of parthenogenetic generations there always appear sexuparae alatae and, finally, sexuales, the latter form being an obligatory link of the complete life cycle of this holocyclic species.

The dispersal of this species is accomplished only by sexuparae alatae migrating to unifested vines.

D. vitifolii infests not only American, but also European varieties of grapes; all the forms of D. vitifolii are dangerous for European varieties. The efficient control system, therefore, requires the elaboration of methods of combatting each of these forms.

The resistance of grapes to phylloxera is based on the capability of their cells to neutralize, to some extent, the action of the salivary enzymes of phylloxera and to intensify the synthesis of complex organic substances in the damaged parts of the plant.

The survival of some individual plants and of some strains under the conditions of long-lasting infestation, reported by practical viticulturists from the Ukraine, Moldavia and Transcaucasia suggests the possibility of successful production of phylloxera-resistant strains by clonal selection.

Among the protective measures the following appear to be the most promising:

1) The production of phylloxera-resistant strains of European varieties by clonal selection.

2) The fumigation of the superficial layer of the soil combined with the spraying or dusting of the superterranean part of the vine.

*In particular, Börner (1930), who has reinstated the correct name of this species (Dactylosphaera vitifolii Schim.).

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LEAF ROLLERS (LEPIDOPTERA, TORTRICIDAE) INJURIOUS TO FRUIT CROPS IN THE FLOOD-PLAIN OF THE OKA RIVER

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Up to the present, an insufficient study has been made of the specific identity of those leaf rollers which are injurious to fruit crops and of their biology, under conditions prevailing in the central part of European USSR. With this deficiency in mind, we have selected this particular group from among all the garden pests of the region lying within the Oka River flood-plain for special study.

The information set forth in this paper was acquired during the summers of 1954 and 1955 as a result of research carried out in the gardens of collective farms in certain parts of the Ryazan region, situated in the flood-plain of the Oka River (Shilovo, Izhevsk and Spassk districts). The principal observations and experiments were made at the Kalinin Research Station orchard in the Shilovo district.

In order to determine the species of leaf rollers concerned in the injury to trees, regular collections, were made every 5 days in gardens containing fruit and other trees and also from forestry plantations; samples of not less than 100 caterpillars were taken and the moths from them were bred out in the laboratory.

For observations on the development of the leaf rollers, we used caterpillars reared in cages in the laboratory and in gauze sleeves on the branches of trees in the garden. In addition to this, observations were made daily on the populations in gardens, together with periodical estimations of their abundance, their distribution among the foliage, the extent to which they were parasitized, etc.

Over the whole region (Shilovo in the Ryazan region, 1955), we discovered 15 species of leaf roller; the relative frequencies of the different species expressed as a percentage of the total number of moths which were bred out is as follows.

1.	Cacoecia rosana L. – Rose leaf roller	73.7%
2.	Pandemis ribeana Hb. – Currant leaf roller	6.2
3.	Tmetocera ocellana F. – Bud worm	5.5
4.	Pandemis heperana Schiff. – Willow leaf roller	4.5
5.	Cacoecia xylosteana L. – Golden variegated leaf roller	2.4
6.	C. crataegana Hb. – Hawthorn leaf roller	2.1
7.	Tortrix diversana Hb.	2.1
8.	Cacoecia lecheana L. – Leaden striped leaf roller	3.5
9.	C. costana F.	
10.	C. sorbiana Hb.	
11.	C. lafauriana Rag.	
12.	Tortrix bergmanniana L.	
13.	Argyroploce ochroleucana Hb.	
14.	A. urticana Hb.	
15.	A. variegana Hb. – Variable fruit-tree leaf roller	

We have made the most detailed study of the three species which occurred most abundantly, i.e., the rose and currant leaf rollers and the bud worm.

The rose leaf roller (Cacoecia rosana L.) is one of the most abundant and widespread species, injurious to tree and soft fruit crops. It is a noted pest of fruit trees in almost all European countries and in North America. In the USSR, this insect occurs in almost all regions, but particularly severe damage has been recorded from the southern European parts of the USSR (Tyumeneva, 1937; Panshin, 1940, 1950; Shcherbakov, 1940, 1954; Efremova, 1953; Livshits and others, 1955; Vasil'ev, 1955 and others). Mass outbreaks of rose leaf rollers were noticed during the years 1951-1955 in the central part of European USSR (Savzdarg, 1953, 1954a, 1954b).

Life history. The rose leaf roller, throughout its range, has a single generation per annum and passes the winter in the egg stage; this is independent of geographical position or climatic factors.

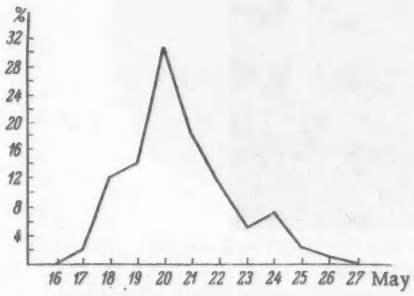

Fig. 1. Emergence of the caterpillars of the rose leaf roller from eggs which have overwintered 1955 (Shilovo, Ryazan region). Vertical axis – percentage of eggs giving caterpillars.

Throughout the Ryazan region, the caterpillars commence their emergence from the eggs in spring at the time when buds are opening on the apple trees (variety "Antonovka Ordinary") and complete their emergence before the beginning of flowering. The first caterpillars were observed to leave their eggs in 1955 on May 17th, 18 days after the day mean temperature had risen above 8°C. (Bichina in 1952 gave 8° as the minimum threshold value for development of the egg). Accroding to Belosel'skaya (1941), hatching of the eggs takes 13-15 days at temperatures between 10 and 15°. The longer time for hatching in 1955 may have been due to the fact that during the period of their active development (i.e., from 1-17th May) the eggs were subjected to a rather low temperature – on May 3rd, when the day mean temperature fell below 8°.

The hatching of the eggs is completed at the end of 8-9 days (Fig. 1); the maximum emergence of caterpillars was observed to take place 3-5 days after the appearance of the first hatchings.

On emerging from the egg, the caterpillar is dirty green in color with the hand and prothorax black; its length is 2 mm. Being negatively geotactic, each caterpillar, 10-20 minutes after leaving the egg, moves up the trunk of the tree, toward the crown. Our attempts at compelling the larvae to go in other directions met with no success. If caterpillars were placed in a test tube, we found that they responded to the least deviation of the angle of the tube from the vertical, by adjusting their movement so that they moved in the new upward direction.

The first caterpillars were seen to reach the crown of the apple trees on May 19th, i.e., 2 days after the commencement of hatching of the eggs. On attaining the crown, the majority of the larvae made their way into the opening buds where they could be found feeding on the young leaflets. Small holes can be seen in the leaf laminae where the caterpillars have gnawed their way through; at the periphery of each hole there is a small amount of excrement and silk webbing.

By the time the fruit trees are ready to blossom, the flower buds may be completely enveloped by the silken webbing of the caterpillars. Within the flowers and the buds, the caterpillars often feed not only on the stamens and carpels, but also on the petals.

The caterpillars of the first instar skeletonize leaves, leaving only the small veins. Caterpillars of later instars (III-V) cause from 1 to 4 leaves to roll up along their midribs and they join the leaves together into a tube with silk webbing (see Fig. 2). Within each tube, a caterpillar can be found eating away at the laminae of the leaves, producing holes of different shapes and sizes and also causing indentations at their margins (see Fig. 3).

The caterpillars also damage the fruit by eating away at the surface and producing hollows and pits, some of which may be quite large (see Fig. 4).

The caterpillar stage lasts from 40-60 days and is usually completed between the end of June and the middle of July. The period during which the larvae are most numerous and do the greatest amount of damage

extends over 30-35 days, coinciding with the month of June. By July, the damage is less, as at this time the larvae are pupating or have already done so.

The high temperature of June speeds up larval development. For example in 1954, when the day mean temperature for the month was 20.1°, the majority of caterpillars had completed their development and pupated by the 20-25th of June, i.e., 35-40 days after their emergence from the egg. In 1955, when the temperature

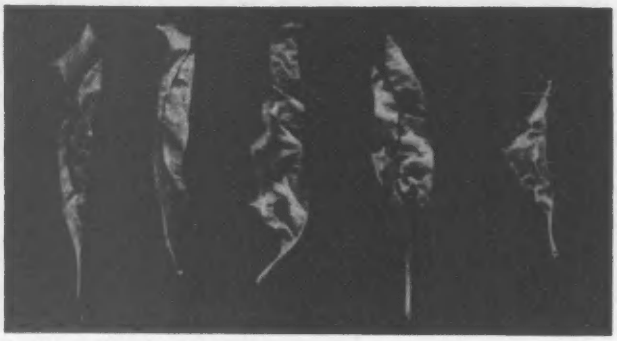

Fig. 2. Rose leaf roller attack on apple leaves.

for the month of June was considerably lower than in 1954, and only reached 16.4°, with day mean temperature as low as 11-12° occurring frequently, the development of the caterpillars was retarded and the majority did not pupate until the end of the first ten-day period in July (see Fig. 5).

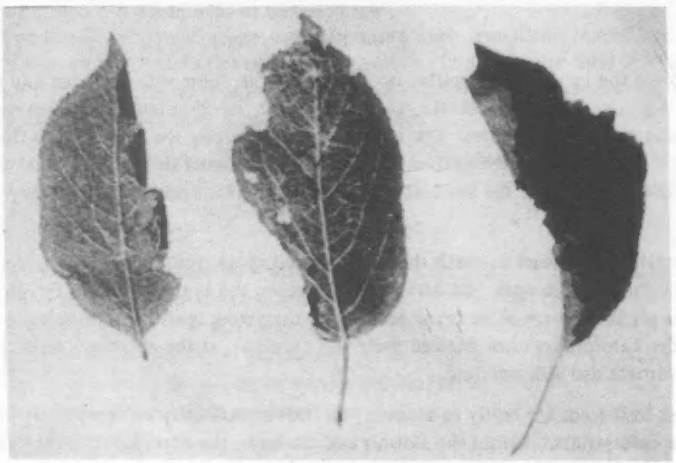

Fig. 3. Damage to leaves of the apple tree by the rose leaf roller.

The period of larval life in nature, for this species is, on the average, about a month. There are five instars during larval life; each instar lasts from 5-8 days.

Pupation of the caterpillars took place on the same leaf as that on which feeding occurred. The period of pupal life for the species was found to be 10-14 days.

In 1954, the flight of rose leaf-roller moths was found to begin on the 20th of June, but in 1955 it did not begin until the 29th-30th of June. The flight was a protracted one and usually lasted longer than a month. In 1955, flight period of this species was especially prolonged and it was possible to find the moths as late as

the second half of August. The period of maximum numbers of moths commences 5-7 days after the beginning of the flight and lasts for another 7-8 days. During this time the maximum intensity of oviposition may be found to occur.

In Table 1, is given data relating to the fecundity of moths under laboratory conditions.

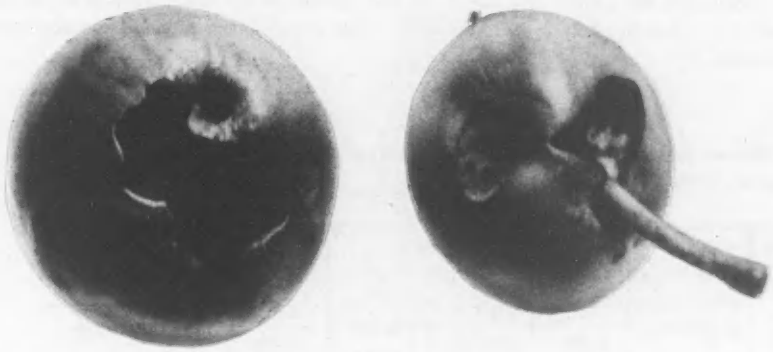

Fig. 4. Damage to the apple fruit by caterpillars of the rose leaf roller.

From this table, it is seen that during her lifetime the female moth lays, at 3-5 distinct ovipositions, from 124 to 173 (a mean of 147) eggs. The mean number of eggs produced at each oviposition is 40.5 and varies from 13 to 82. Oviposition totals collected in the field were somewhat greater. In 1954, the mean

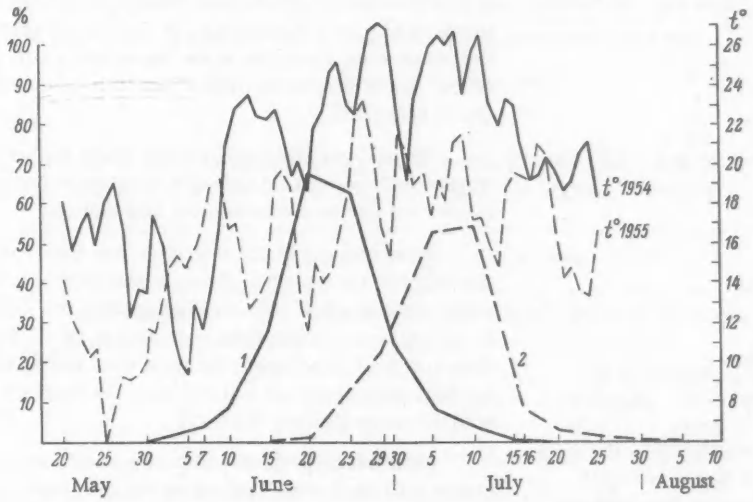

Fig. 5. Dynamics of pupation among caterpillars of the rose leaf roller during 1954 (1) and 1955 (2). Vertical axis (left side) – percentage of pupating caterpillars.

number of eggs per laying in the field attained 66 (maximum 124, minimum 26). The period of oviposition lasts 24-37 days (see Fig. 6); the period of maximum intensity of oviposition extends over 5-10 days.

Shevyrev (1893) for the steppe zone, Panshin (1940) for the southern Ukraine, Novopol'skaya (1950) for the Crimea, and Bichina (1952) for Moldavia have shown that the rose leaf roller lays its eggs on the trunk

and on the basal branches of apple trees and pear trees. According to our observations in the Ryazan region, the eggs of this species are deposited on the trunks of apple, cherry and other fruit trees; on black currant bushes, however, the eggs are deposited on the lower branches near the ground.

Examination of a large number of tree trunks (about 500) revealed that the number of eggs diminished proportionately to the distance from the ground. It is evident from Fig. 7, that the greatest number of ovipositions (77-79%) occur at distances not greater than 10-15 cm from ground level; the number of ovipositions at distances greater than 0.5 m constitute only 2-3% of the total. Only single groups of eggs have been noticed on the bark of the branches.

TABLE 1

Fecundity of Female Rose Leaf-Roller Moths as Observed in Laboratory Cages (Shilovo, Ryazan regions, 1955)

No. of pairs	Mean No. of ovipositions per female	Fecundity of a single female			No. of eggs per laying		
		mean	maximum	minimum	mean	maximum	minimum
10	3-5	147	173	124	40.5	82	13

The difference in behavior, with respect to oviposition, between moths from the middle zone of the USSR (Ryazan region) and those from the more southerly regions, can be explained by the fact that in the south (Crimea, Ukraine, Moldavia), the winter is not characterized by such intense frosts as those which usually occur in the middle strip of the USSR. In the Ryazan region, where the temperature during the winter season often falls to -3° and below, the distribution of ovipositions must be well adapted to winter conditions.

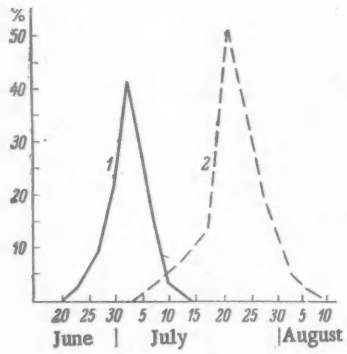

Fig. 6. Dynamics of oviposition in the rose leaf-roller moth during 1954 (1) and 1955 (2). (Shilovo, Ryazan region). Vertical axis - No. of eggs as a percentage of the total number laid.

Ovipositions which occur on the lower part of tree trunks, around the base, will lie under the snow cover during the winter months and thus be protected from frost damage.

When they are laying their eggs, the female moths seek out the secluded and protected places on the trunk and those least exposed to the weather. We have noticed that the greatest number of eggs are layed on those trees around the trunks of which there is a thick grass layer. On apple trees around which the grass has been cleared and the soil dug over, the number of ovipositions is significantly less (see Table 2).

From this table it may also be seen that the number of egg masses laid by female leaf rollers was the greatest on the apple trees, between which black currants were planted.

The rose leaf roller is a typical polyphagous species Bichina (1952) lists 72 plants species belonging to 23 families upon which its larvae may fee. The caterpillars were a destructive element in all the gardens where any kind of fruit trees were grown throughout the region dealt with in our researches; they were a pest of other trees also, particularly in gradens lying near to sheltering belts of trees and wood lots. Apple trees and black currant bushes suffered the greatest amount of damage among cultivated species. Among other species of trees, lime, ash-leaved maple, ash, elm and yellow acacia were all heavily attacked; spindle tree (Euonymus) was

less heavily damaged and oak, poplar birch and aspen were hardly attacked at all. Single caterpillars were found on lilac and wayfaring tree (Viburnum lantana).

In order to study the effect of different food plants on the development of rose leaf rollers, we reared caterpillars on diets consisting of both highly preferred and less highly preferred species of plant (see Table 3).

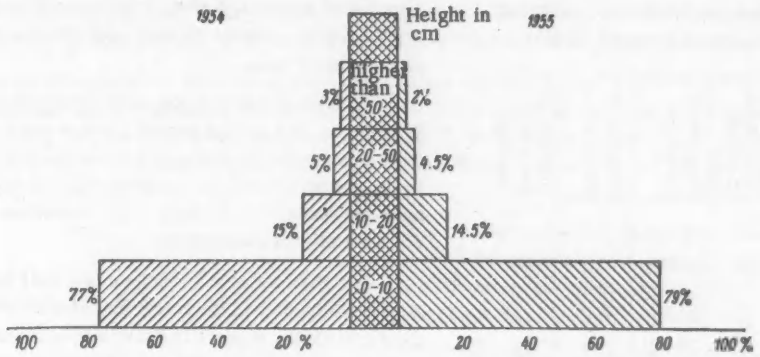

Fig. 7. Distribution of egg masses, belonging to the rose leaf roller, on the trunks of apple trees (Shilovo, Ryazan region). Along the abscissa – No. of egg masses (ovipositions) as a %.

For these experiments we selected the following:

1) Apple and blackcurrant – the most acceptable of the cultivated fruit trees.

2) Cherry, pear and plum – less acceptable among cultivated fruit trees.

3) Lime, yellow acacia, maple and elm – preferred species among deciduous trees.

4) Oak and aspen – less acceptable species among deciduous trees.

TABLE 2

Correspondence between the Number of Egg Masses (ovipositions) on the Trunks of Apple Trees and Different Conditions of Cultivation (Shilovo, Ryazan region, 1954-1955)

Years of observation	No. of trees examined	Mean No. of egg masses per tree				
		pure stands of apple	intervals between apple trees occupied by		conditions of terrain around trees	
			black currant bushes	cherry trees	soil dug over	soil overgrown with weeds
1954	125	4.0	58.8	41.6	13.6	52
1955	125	6.8	10	7	7	17

From Table 3, in which are set out the results of our experiments, it is evident that different foods strongly infouence the survival rate of the caterpillars; among caterpillars fed an unfavorable diet the death rate was high. For example, out of the 100 caterpillars reared on oak or aspen leaves only 3 pupated and gave moths; The remainder died before pupation. The diet of the caterpillars, morover, has a profound influence on the fecundity of the resultant moths.

From Table 4, it may be seen that the number of eggs per oviposition, as collected from different tree species from gardens and woodland, shows considerable variation. The number of eggs from each laying from apple trees, black currant bushes and cherry trees collected in gardens, is significantly higher than the number of eggs on other plants in woodland.

TABLE 3

Development of Rose Leaf Roller on Different Food Plants (Shilovo, Ryazan region, 1955)

Food plant	No. of first instar larva in experiment	Duration of larval life	Duration of pupal life	Survival rate (as a percentage)
Apple	50	26—28	10	90
Black currant	50	27—30	8—9	88
Cherry	50	27—30	11	86
Plum	50	28—31	9	86
Pear	50	25—28	10—11	86
Lime	50	27—30	8—9	82
Yellow acacia	50	27—31	9—10	82
Maple	50	27—29	8—10	76
Elm	50	26—29	9—12	72
Aspen	50	30—31	11—12	4
Oak	50	31	12	2

TABLE 4

Number of Eggs per Oviposition Layed by Rose Leaf-Roller Moths on Different Tree Species (Shilovo, Ryazan region, 1955)

Species	No. of eggs per oviposition		
	mean	max.	min.
Apple	66	103	37
Cherry	64	101	36
Black currant	56.6	109	23
Lime	52.5	89	17
Elm	42.5	54	22
Yellow acacia	36.4	52	25
Oak	34	65	18

On the basis of these findings, it is possible to conclude that the rose leaf roller has a narrow range of preferred food plants, and when it feeds on these, the caterpillars display a higher survival rate and the resultant moths produce more eggs.

The black currant leaf roller (Pandemis ribeana Hb.) This species is a serious pest in gardens and timber plantations throughout the European part of the Soviet Union and in the northern territory; in spite of this, hardly an study has been made of its biology under conditions of the middle zone of fruit cultivation.

We have found the black currant leaf roller on all cultivated species of fruit trees and also on many forest trees and shrubs, especially lime, ash, ash-leaved maple and elm; strangely enough, this species was met with less frequently on black currant than on apple.

Throughout the southern states of European USSR the black currant leaf roller has one complete generation and part of a second per annum (Tyumeneva, 1937; Bichina, 1952 and others).

In the Ryazan region our data shows this species to have one generation a year. It overwinters here, as elsewhere, in the third or more rarely, the fourth larval instar, surrounded by a tough silken cocoon. We found the majority of caterpillars, during the winter, hibernating on tree trunks under bits of raised bark or in crevices, etc., at a height of 0.5-1.0 m from ground level. More rarely the caterpillars were found at the base of the lower branches, in the angle formed by trunk and branch.

Our observations showed that the caterpillars began to emerge from their hibernacula during the first 10-day period in May, when the mean daily temperature reached 10-14°, a period which coincided with the opening of the flower buds on apple trees (variety Antonovka Ordinary). The period of emergence of black currant leaf-roller caterpillars from their hibernacula is a very protracted one and therefore it is possible, at the end of May, to find both pupae and newly emerged caterpillars. This state of affairs can be explained: first, as resulting from temperature variations (during May the day mean temperature varies from 21-6°), and secondly as resulting from the different conditions of growth exhibited by the trees on which the caterpillars hibernate. As a rule, caterpillars on apple trees surrounded by a thick ground cover of black currant bushes or yellow acacia emerge late, due to the retarding effect of shading on the tree trunks which suffer a reduction in their surface temperature as compared with unshaded ones.

On coming out of hibernation the caterpillars damage the opening leaf buds, the young leaves, flower-buds and flowers. Moreover, the caterpillars in their later instars do considerable damage to the young fruits (carpels and receptacles), by eating away very deep holes in their tissue.

On the average, every caterpillar eats for two or three weeks in the spring before pupating, but because of the great variation in time of emergence from hibernation, it is possible to encounter caterpillars in nature over a period of 1.5 months (i.e., from the first ten-day period in May to the end of the second, or beginning of the third 10-day period in June). In 1955, the caterpillars were still to be found at the beginning of July.

The period of pupation is also a protracted one. Pupae are encountered from the second 10-day period in June to the end of July. Depending on air temperature, the duration of the pupal stage may vary from 10-17 days. For example, when the mean temperature was 11.7°, the pupal stage was found to last 16 days (from May 23rd to June 8th), whereas at a mean temperature of 19.6°, the period of pupal life was reduced to 10 days (from June 25th to July 6th).

TABLE 5

Relative Numbers of Eggs Layed by Currant Leaf Rollers in Different Regions of the Canopy of Apple Trees (Shilovo, Ryazan region, 1955)

Time of counting	No. of lengths (1 m) of branches exam'd	Part of canopy	Total no. of egg masses (oviposition) observed	Of these	
				on the leaves	on fruit and branches
10—20 July	60	Upper part	13	10	3
	60	Middle part	15	12	3
	60	Lower part	3	3	—
		Total	31	25	6

In 1954, the first moths were found at the beginning of the second 10-day period in June, but in 1955, we did not notice them until a little later: in the middle of the third 10-day period of the month.

The flight of the adult moth is again a very protracted one and lasts for about 2 months, but the period of maximum numbers only lasts for 10 to 12 days.

At the end of the third 10-day period in July, numbers of recently emerged caterpillars were discovered in the crowns of apple trees. The eggs from which these caterpillars had hatched were deposited in groups by the female moths on the leaves, the fruits and the fruit-bearing branches. From Table 5, it is evident that the majority of eggs were deposited on the upper and middle regions of the canopy.

In 1954, the mean number of eggs per laying was 64 (maximum 97, minimum 28), whereas in 1955 the mean number was 59 (maximum 89, minimum 25). Each female oviposited on 1-4 occasions in the course of her life. The fecundity of their species is very high. Dissection of moths which had just emerged from the pupa, revealed the presence of 284 to 357 oocytes in the ovaries (mean number 313).

The duration of the egg stage depends to a considerable degree on the temperature of the environment. For example, eggs layed on the 15th of June hatched on July 3rd, i.e., in 18 days, when the mean temperature for the period was 17.1°. Eggs layed on July 25th however, when the mean temperature for the period of development was 20.3°, only took 8 days to hatch, i.e., on the 2nd of August. The period over which caterpillars emerge from the eggs is a very long one and extends over approximately 2 months. The greatest number of caterpillars emerges from the eggs at the end of July or the beginning of August.

The period during which the caterpillars of the new brood feed in autumn extends over approximately a month. On attaining their third instar, the larvae cease feeding and seek out their hibernation places.

While they continue to feed, the caterpillars are to be found on the lower side of leaves sometimes on those that have been previously damaged by leaf-roller larvae of the spring brood. From 3 to 10 individuals occur on a single leaf, which is reduced to a skeleton by their feeding on it from below, only the upper epidermis and small veins being left (see Fig. 8). That portion of the leaf which has been damaged by the caterpillars has its lower surface drawn together and held by silken webbing and is folded in such a way that the larvae are to be found within the fold, under the webbing.

The bud worm (Tmetocera ocellana F.), throughout the southern regions of the USSR is considered the next most important pest of gardens after the apple leaf roller.

In the Ryazan and Moscow regions, we have found that bud-worm damage is confined to apple trees. In the literature, however, this species is described as being polyphagous and it is stated that the bud worm damages several species of forest tree and certain bushes in addition to all cultivated fruit trees. The typical form of this species – var. lariciana Z., which is distributed throughout Siberia and the northern territories – frequently damages timber trees (Danilevskii, 1955).

In the Ryazan region, this bud worm has a single brood per year, but in the south of the USSR, there may be two (Tyumeneva, 1937; Bichina, 1952; Efremova, 1953).

The 3rd instar larvae, or less frequently the fourth instar larvae hibernate in cocoons of silk webbing under fragments of bark on the trunk or occasionally under withered leaves which are still adhering to the branches.

The emergence of bud-worm caterpillars from the hibernacula in spring takes place during the first 10-day period in May, i.e., at the same time as the currant leaf-roller caterpillars emerge. After coming out of hiberation the bud-worm caterpillars ascend to the crown of the tree and penetrate the buds at the time when they are swelling. On the surface of the buds which have been thus attacked, it is possible to observe quite small holes, surrounded by a small amount of silk and excrement. Inside the bud, the caterpillar chews out a deep, sinuous tunnel which reaches the center of that structure; such a bud does not open as a rule, but merely dries up and withers. While it is inside the bud, the larvae does not make for itself the characteristic little case; this is made later when the larva moves over to the unfolding leaves, and spinning silk webbing around 3-5 of them, it draws them together into a compact bundle. The leaves which constitute such a bundle turn yellow and wither.

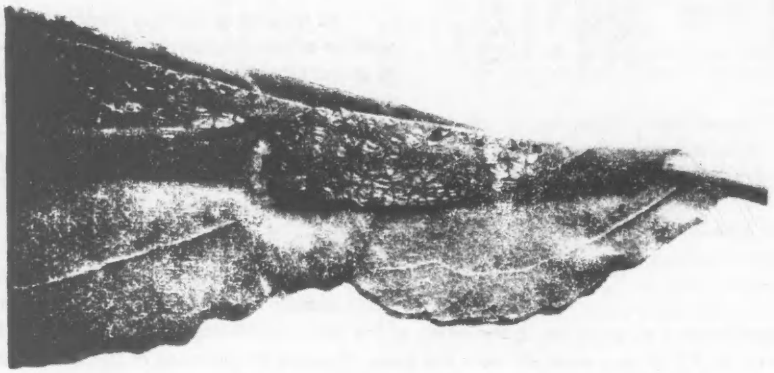

Fig. 8. Injury to apple leaf caused by caterpillars of the new generation of currant leaf rollers.

The period of development undergone by the caterpillars after coming out of hibernation is a protracted one and lasts 1.5-2 months. Certain caterpillars may be found in the canopy of apple trees as late as the middle of July.

The pupal stage lasts from 10-15 days. The period over which the moths are on the wing is a lengthy one and lasts more than a month. In 1954, bud-worm moths were on the wing from the last 10-day period of June (24th) to the end of August; in 1955, the flight began later and did not finish until the second 10-day period of August.

The fecundity of the female bud-worm moths is rather high. On dissection of the femal moths, 150-210 eggs were counted in the ovaries and of these, many were mature and ready for laying.

The egg stage lasts from 7 to 15 days. In 1954, the young larvae made their appearance in the first 10-day period of July, whereas in 1955, they appeared at the beginning of the third 10-day period of the same month. On leaving the egg, the caterpillars of the new brood make for themselves a tent out of silken webbing and cover it with their own excrement; this is completed by the end of the first day or during the second; this

is completed by the end of the first day or during the second. The yound caterpillars skeletonize the lower part of leaves leaving the upper epidermis untouched. Very often, one can discover two leaves fastened together by silk webbing, one yellowed and almost completely torn away from its branch whereas the other is still attached. The caterpillars damage the leaves mainly along the midrib, drawing the leaves together into a little case

The period during which the caterpillars feed may extend over two months (from the end of July to the beginning of September) but the majority of caterpillars cease to feed about the middle of August and go into hibernation.

Parasites and Predators of Leaf Rollers

From our own observations in the Ryazan region, it is apparent that parasitic insects are one of the principal factors in reducing the numbers of leaf rollers. In 1954, 39.5% of the leaf rollers were destroyed by parasites. In 1955, the number of leaf rollers parasitized rose to 59.6% of the total population. Of the rose leaf-roller eggs layed during 1954, 14.5% were parasitized by Trichogramma sp. and in 1955 the number infected with this parasite was 30.5% of the total.

From the total number of eggs, larvae and pupae of leaf rollers which we collected, 48 different species of parasites were raised. The majority of these were from larvae and pupae of the rose leaf roller.

The greater part of the parasites obtained, belonged to the order Hymenoptera. Of these, 32 species were representative of the Ichneumonidae, 9 species were members of the Braconidae and 6 species belonged to the Chalcidoidea.

The ichneumonid species most frequently encountered were Angitia fenestralis Holmgr., A. armillata Grav., A. exaraeolata Rtzb., Phytodietus polyzonias Foerst., Apechtis rufata Gm., and A. resinator Thunb. Angitia fenestralis is a particular important species of parasite as it occurs in great numbers and parasitizes the first and second instar larvae, thus curtailing the potential damage done by the larvae.

The majority of the Ichneumonidae which attack leaf roller caterpillars are endoparasites. Of the ectoparasitic Ichneumonidae, the species Phytodietus polyzonias was encountered most frequently; this species develops on the caterpillars of the rose leaf roller and the willow leaf roller.

Of the Braconidae, Apanteles rubecola March and Microgaster meridiana Hal. were the two species most frequently encountered.

Except for the egg parasite, Trichogramma, the chalcid parasites were of no real practical importance. Trichogramma parasitized the eggs of the rose leaf roller throughout the whole period of oviposition. Eggs collected two days after being laid were found to be parasitized by this species. No other tortricid except the rose leaf roller was found to have its eggs attacked by this chalcid genus.

Among dipterous parasites of tortricids five species of the family Larvivoridae were noted. One of these – Exorista westermanni Zett.–was encountered more often than the rest, but its importance was considerably lessened as a result of the contemporary occurrence of Itoplectis alternans Grav., a species which behaves as a primary – and a super – parasite already, and which lays its eggs both in healthy caterpillars and those already parasitized by Exorista westermanni.

Insect predators were of no great importance in bringing about a reduction in numbers among leaf rollers.

Control Measures

Various methods aimed at controlling the damage done by leaf rollers in orchards can be recommended; in the autumn or early spring the trunk and main branches of trees should be thoroughly scraped in order to get rid of old, detached pieces of bark, after which these parts of the tree should be treated with a 6-8% oil emulsion to destroy the hibernating ova and larvae; washing or spraying the trees with DDT preparation should be carried out during the period when the caterpillars are sheltering in the rolled-up leaves.

The data and information regarding the biology and ecology of leaf rollers obtained in the Oksk district can serve as a basis for the more detailed elaboration of a system of control measures.

Our own observations show that methods of cultivation aimed at improving the growth of fruit trees may, in fact, have a direct effect on leaf rollers and reduce their numbers. For example, because the eggs of the rose leaf roller are laid most abundantly on the trunk of apple trees when the base is surrounded by dense cover of weeds and grass, the destruction of such undergrowth is an obvious necessity.

Moreover, the presence of black currant bushes planted among apple trees favors the multiplication of rose leaf rollers and therefore we recommend that black currant bushes should be replaced by some crop not attacked by leaf rollers, e.g., strawberries or vegetable crops, particularly in districts where the rose leaf roller is a serous pest. In orchards with mixed plantations (apple trees combined with black currants) chemical methods of control by applications of insecticides must be applied simultaneously to both crops.

Arising from our observations that the female rose leaf roller lays her eggs on the lowest part of the tree trunk and on the lowest branches of bushes, we recommend that these regions receive particular attention in the spring spraying with oil emulsion.

Chemical control measures against tortricids must be applied to both cultivated and natural plantations of trees near to orchards, as our results show that the rose leaf-roller and other species of this family may feed on many species of tree (lime, ash-leaved maple, yellow acacia, etc.) besides fruit trees.

SUMMARY

The observations of injurious Tortricidae have been carried out during 1954 and 1955 in the orchards situated in the flood-plain of the Oka river (Ryazan region).

Fifteen species of tortricids were found to occur within the territory investigated, Cacoecia rosana L., Pandemis ribeana Hb. and Tmetocera ocellana F. being the most injurious. The biology of these three species has been studied in detail.

In 1954 and 1955 the abundance of leaf rollers, especially C. rosana, was efficiently suppressed by parasites. The average proportion of parasite-infested larvae in 1954 and 1955 was 39.5% and 53.6% respectively, while the per cent infestation of the eggs of C. rosana with Trichogramma sp. was 14.5% and 30.5%, respectively.

Altogether 48 species of parasites have been reared from the eggs, caterpillars and pupae of tortricids, the majority of which (43 species) were Hymenoptera. Among these, Angitia fenestralis Holmgr. is of greatest importance.

The data on the biology of tortricids obtained in the course of these studies can serve as a basis for the more detailed elaboration of a system of control measures. In the first place the absolute necessity of repeated tillage of the orchards and the destruction of weeds is emphasized.

It is recommended to replace black currants in mixed plantations by some intercrops not attacked by leaf rollers, such as strawberries or vegetable crops. In the mixed plantations where apple trees are combined with black currants, insecticides must be applied simultaneously to both. In spring-spraying with oil emulsions the lower parts of tree trunks and the shrubs must be sprayed particularly thoroughly, the major part of egg batches of C. rosana being concentrated there. Chemical control measures against tortricids must be also applied to forests in the neighborhood of orchards.

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EURYDEMA WILKINSI DIST. (HEMIPTERA. PENTATOMIDAE) AS A PEST OF CABBAGE PLANTS IN THE KZYL-ORDA REGION

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Wilkins' cress bug, Eurydema wilkinsi, is one of the most serious pests encountered by the market gardener in the Kzyl-Orda region of southern Kazakhstan.

A study of the biology and destructive propensities of this pest was carried out during 1956-57 under the guidance of V. V. Yakhontov. The ecological research in connection with this study was conducted at the "Kommunizm" State Collective Farms and the Dzhambula estates in the Syr-Dar'insk region, at the Kzyl-Orda State Agricultural Station and in the gardens of the Pedagogical Institute at Kzyl-Orda.

Dietary specializations. Our observations show that E. wilkinsi is a markedly oligophagous species. In order to determine its precise diet under field conditions, we carried out observations into its various habitats (along field boundaries, by the side of roads and ditches, on fallow land, pasture land and in fields of maize, rice, lucerne, wheat, etc.) at different times of the year. Methods of investigation were those described by Shapiro (1951b).

The results of our observations and the counts made of E. wilkinsi indicate that the bugs occurred wherever there were cruciferous plants among the vegetation. In those habitats from which cruciferous plants were absent, we did not find any bugs. Data with respect to the dietary specializations of E. wilkinsi is given in Table 1.

From this table it is evident that E. wilkinsi, under the conditions prevailing in this region, occurs in enormous numbers in the spring months on wild cruciferous plants (Lepidium draba L., L. crassifolium W. et K. Berteroa incana L.).

In addition to the observations and counts made in the field, experiments were carried out in the laboratory in order to determine the extent of dietary specialization in this species. The insects were reared in 500 ml vessels, the openings of which were covered with gauze, which was secured in position by an elastic band. The experiments were carried out at temperatures from 23-34° and at a relative humidity of 35-45%. Leaves of lucerne, wheat, rice, maize, alyssum, hoary cress, cabbage and radish were employed in these experiments (see Table 2).

From this table it may be seen that the larvae and imagos survived only when fed on cruciferous plants, whereas when given plants belonging to other families as food they died sooner or later.

The results of these experiments and observations in the field demonstrate that E. wilkinsi feeds only on the leaves and reproductive organs of various species of cruciferous plants, particularly the leaves of white cabbage, hoary cress, thick-leaved cress.

In common with the findings of other authorities (Kemner, 1915; Khebnikova, 1926; Bogdanov-Kat'kov, 1926; Kovrigin, 1956), our results indicate that the possibility of Eurydema feeding on plants other than members of the Cruciferae, must be considered very doubtful. This agrees with the results obtained by Shapiro (1951a,b) from this observations and experiments on the ornate cress bug (E. ornata L.), the mustard bug (E. festina) and the rape bug (E. oleracea L.) carried out in the Krasnodarsk region.

TABLE 1

Distribution of Eurydema wilkinsi Dist. According to Habitats and Food Plants on State Farms in the Syr-Dar'insk Region and in the Neighborhood of Kzyl-Orda in the Kzyl-Orda Region of Kazakhstan in 1957

Date of record	Habitat	Name of plant	No. of plants examined	Feeding of bugs	No. of E. wilkinsi indiv.
29 IV—20 V	Field of winter wheat	Wheat	300	—	—
29 IV—20 V	Maize field	Maize	300	—	—
29 IV—20 V	Boundaries, edges of roads, ditches	Hoary cress (Lepidium draba L.)	300	+	658
29 IV—20 V	Pasture land	Hoary cress (Lepidium draba L.)	300	+	365
		Thick-leaved cress (Lepidium crassifolium W. et K.)	200	+	196
29 IV—20 V	Between rows of trees in orchards (in nursery beds containing vegetables)	Hoary cress	200	+	594
		Thick-leaved cress	200	+	275
		Alyssum (Berteroa incana L.)	200	+	211
29 IV—20 V	Fallow land	Hoary cress	200	+	469
		Thick-leaved cress	200	+	298
29 IV—20 V	Lucerne field	Lucerne	200	—	—
		Hoary cress	200	+	262
20 V—12 VI	Rice field	Rice	300	—	—
20 V—10 VI	Seed cabbage plants in Institute garden	Seed cabbage	50		236

Note: In the Kzyl-Orda region, E. maracandica Osh is to be found as well as E. wilkinsi.

TABLE 2

Duration of Life among Larvae and Adult Eurydema wilkinsi Dist. as Determined by Their Feeding on Different Species of Food Plant

Food plant		Mean duration of life (in days)	
family	species	of larvae	of imagos
Cereals (Gramineae).	Maize (Zea mays L.)	5	13
	Wheat (Triticum sp).	6	14
	Rice (Oryza sativa) . .	4	12
Legumes (Leguminosae).	Lucerne (Medicago sativa L).	7	15
Cruciferae (Cruciferae).	Alyssum (Berteroa incana L.)	Up to adult	More than 35 days
	Cabbage (Brassica oleracea L.)	The same	The same
	Hoary cress (Lepidium draba L). . .	» »	» »
	Radish (Raphanus sativus L.)	» »	» »

Annual cycle. The observations carried out over two seasons on 5 collective farms in the Syr-Dar'insk region and around Kzyl-Orda indicate that E. wilkinsi hibernates under plant remains in various habitats: roadside verges, cabbage fields, among leaf litter, in nursery beds, in gardens, under the dried-up leaves of wild cruciferous plants, etc. This species does not hibernate in damp garden soil, in rotting vegetable remains undergoing active bacterial decomposition, or among damp, moldy leaves. In the spring of 1957, we discovered up to 20 bugs per square m in orchards of the "Kommunism" collective farms in the Syr-Dar'insk region, whereever, the trees bordered on cabbage plots which had not been tilled during the autumn of 1956.

According to our observations, individuals of E. wilkinsi first emerge from their hibernating places on sunny days but with the return of colder weather they retire under fallen leaves once again.

In the Kzyl-Orda district, the bugs come out of hibernation in early spring, i.e., at the end of March or early April, when the day mean temperature varies between 6 and 10°. For example, in 1957, E. wilkinsi was first observed on March 26th in the neighborhood of Kzyl-Orda, when the day mean temperature was 8.6°. When the temperature dropped to 3.8°, however, the flight of bugs ceased and was not resumed until the weather became warmer again, i.e., on April 8th, at a day mean temperature of 6.8° (maximum 16.5°). At this time of the year, the bugs were active usually only during the hotter period of the day, i.e., between 11 A.M. and 3 P.M.; which is in general agreement with the data of Sukhorukov (1953) for the Krasnodarsk district.

The bugs begin to feed immediately after they resume activity in the spring. During the first two weeks their diet consists solely of wild cruciferous plants, and this is the most favorable time for carrying out control measures against them. At this time, they are very sensitive to a slight drop in the temperature and therefore in the evening they leave the food plants and spend the night hidden under the soil surface or under remains of the previous year's plants or in cracks in the ground. On cold, cloudy days they remain in these retreats throughout the whole 24-hour period.

Mating takes place only after the bugs have fed for a considerable length of time, i.e., 10-12 days after emerging from hibernation. Eggs are laid in quantity during the third 10-day period of April and in May. During the period of intense oviposition E. wilkinsi deposits an average of one batch of eggs (12) every two days.

The eggs are of the typical pentatomidtype and are enclosed in a thick chorion. In the majority of cases, the female lays the eggs either on the upper or lower surface of a leaf, on the plant stem, on the soil, or on vegetable remains near the food plant, although we have occasionally found eggs at some distance from any food plant, e.g., in the crown of a pear tree, and once on withered apples. Such situations for eggs are, however, the exception.

Under experimental conditions in the field where plants have been covered with gauze sleeving or with bell-jars, eggs were deposited on the gauze and on the glass. In the laboratory, a similar situation prevailed: the bugs preferred to lay eggs on the gauze covers or on the glass sides of half-liter vessels.

E. wilkinsi deposits its eggs in regular, double rows, 6 eggs in a row. During the process of oviposition, the eggs are firmly glued on to the substrate at their bases and glued to each other laterally. Unlike those of other species of Eurydema, the females of E. wilkinsi do not always deposit their eggs in straight lines, sometimes they are staggered. The greatest number of eggs which we found to be laid in a single oviposition was 20-22.

The process of oviposition as described above agrees with the description given by Puchkov and Puchkova (1956). However, according to our observations, oviposition commences in the second half of April and not in the second half of May, as observed by the Puchkovs.

In carrying out observations on oviposition in E. wilkinsi and in studying its fertility under laboratory and experimental conditions in the field, the following techniques were employed.

1) In the experiments designed to reveal the fertility of female bugs, the duration of the egg-phase and the duration of the various larval instars, the insect were reared on plants actually growing under field conditions but enclosed in cages of gauze netting of dimensions 50 x 50 x 60 cm. In all, 10 experiments were set up under such "natural" conditions. A pair of bugs (1 male and 1 female) were placed in each gauze netting enclosure. Five such enclosures were set up around cabbage plants, 5 around hoary cress plants. Each plant was labeled. Every day at 7 A.M., 1 P. M. and 9 P.M., recordings were made of the temperature (by means of a

weekly thermograph) and the humidity (by means of a hygrograph). For the convenience of recording, only a small part of the hoary cress plants were kept under the enclosure. Every day, the isolated plants were examined and the number of eggs which had been laid during the previous 24 hours was counted; after counting, the eggs were removed, unless they were required for a study of the duration of embryonic life when they were left in situ, after careful note had been made of the exact position in which they had been deposited. The bugs were then returned to the enclosure.

2) In experiments designed to reveal the fertility of female bugs under laboratory conditions, we reared the insects in half-liter vessels, labeled with a serial number. The number of eggs laid in a particular flask was recorded in a diary against its own serial number. Males and females which had just emerged from hibernation were placed in the flasks. Ten pairs of bugs were used for these experiments. They were given leaves of cruciferous plants to eat, twice a day; the old uneaten food was removed from the vessels at the same time as the egg counts were made. Recordings of temperature and humidity were made by means of a barothermohygrograph. Up to now, there have been no literature references to the fertility of E. wilkinsi. Our results (see Table 3) show that the fertility of this species, under the conditions prevailing in the Kzyl-Orda region, is very high.

According to our obeservations, oviposition in E. wilkinsi takes place irregularly: females on emerging from hibernation continue to lay eggs for 4 or 5 days after they have eaten sufficient food; the maximum oviposition occurs on 1-2 days, and the process finishes after 7-9 days.

In 1956-1957, both climatic conditions and the biological state of the bug population appeared to favor a high rate of egg production among the females. As was mentioned earlier, in 1957 oviposition commenced during the third 10-day period of April and mass oviposition took place during May. The duration of both embryonic and larval development is as short as that for any species of Eurydema. The length of time required for this development to take place depends on the temperature and humidity of the air. For example, eggs which were laid during the third 10-day period of April took 10-15 days to hatch under field conditions, in which the day mean temperature varied between 9.9 and 20.1° and the relative humidity between 35 and 45%, whereas in the laboratory at a day mean temperature of 19.3-25.6° and a relative humidity of 38-50%, the duration of embryonic life in eggs laid at the same time as those in the field, was only 6-9 days. At a

TABLE 3

Fecundity of Eurydema wilkinsi Dist.

Date of beginning and end of experiment	Experimental site	Food plant	No. of pairs of bugs	Brood	No. of eggs laid	No. of eggs per female		
						mean	max.	min.
7 V—30 VI 56	In the Institute garden	Cauliflower	5	Overwintering	900	180	264	120
		Hoary cress	5	Same	816	161	240	96
10 V—3 VII 56	In laboratory	Various Cruciferous plants	10	»	1460	146	252	84
28 IV—25 VI 57	In the Insitute garden	Cauliflower	5	»	848	169	252	108
		Hoary cress	5	»	756	151	216	96
28 IV—30 VI 57	In laboratory	Various Cruciferous plants	10	»	1392	139	228	84
13 VI—24 VIII 58	In Institute garden	Cabbage	5	1	823	165	240	132
		Hoary cress	5	1	648	129	204	84
13 VI—20 VIII 58	In laboratory	Various Cruciferous plants	10	1	1210	121	180	72

temperatur of 26° the development of eggs takes only 4-5 days. Finally, at a day mean temperature of 28° the eggs hatch after 2 days.

The complete period of development up to the time of the mass flight of the young, adult bugs took not more than 30 days in May, and only 25 days in July and August. Early first-instar larvae were observed at the end of April, but the mass emergence of larvae from the eggs did not take place until the first 10-day period in May. The first winged adults appeared on May 29th-31st in 1957, and the mass appearance of winged adults took place between the 1st and 12th of June.

Under conditions prevailing in the Kzyl-Orda region, E. wilkinsi produces 3 generations per annum in the field. We observed the following possible phenological sequence to the life cycle in E. wilkinsi: emergence from hibernation at the end of March and the beginning of April; appearance of the first brood of adults at the end of May to the beginning of June; appearance of the second brood of adults during the second half of July; appearance of the third brood of adults at the end of August; hibernation takes place at the end of October or the beginning of November.

Damage by bugs. As stated earlier, the bugs after emerging from their hibernating places, feed on wild cruciferous plants. Changes in the vegetation of a particular region, such as result from the introduction of crops, cause the insects to transfer themselves to cultivated plants. In the Kzyl-Orda region, cabbages and other vegetable crops are of comparatively recent introduction, and where cabbages are not grown in this region, the bugs can and do continue to reproduce normally on wild plants until late autumn.

In order to ascertain the effect of the bugs on the development and yield among cabbage crops and also to estimate their capacity for damage in relation to the numbers present in the cabbage fields of the "Kummunizm" State Farm, Syr-Dar'insk region, we selected, for experiment, 30 plants which were at the same stage of development and were growing under identical conditions at the time when the bugs were flying to the cabbage plots.

It was convenient to employ 3 degrees of infestation. (1) Consisted of plants, on which 3 bugs were placed at the beginning of the experiment, (2) consisted of plants with 6 bugs and (3) consisted of plants which were given 12 bugs and a set of eggs. Five series of repeats were set up for these experiments.

TABLE 4

Results of Experiments on Eurydema wilkinsi Damage to Early Cabbage (variety Number One) on the "Kommunizm" State Farm, Syr-Dar'insk Region, 1957

No. of bugs per cabbage plant	Dates				Mean value per plant			Reduction in yield of marketable cabbage heads compared with controls (as a percentage)
	planting date	date of beginning of attack	date larvae emerged	date of harvesting	wt. of plant without stump (in g)	of which		
						weight of leaves	wt. of marketable head (in g)	
3 specimens	28 V	16 VI	—	9 VIII	1145	624	521	38.2
6 specimens	28 V	16 VI	—	9 VIII	680	473	207	75.4
12 specimens	28 V	16 VI	—	9 VIII	311	311	0	100
1 egg laying*	28 V	24 VI	21 VI	9 VIII	438	345	93	89
Control	28 V	—	—	9 VIII	1812	968	844	0

* From eggs laid in laboratory.

In order to avoid the cabbage plants being visited by other pests or by predators and parasites of E. wilkinsi, each plant was covered with a gauze netting-cage (60 x 60 x 70 cm). In addition, we set up for comparison, a set of 5 cabbage plants under gauze netting but without bugs and a further set of 5 cabbage plants without gauze covers and not infested by bugs. The bugs were allowed to continue their damage to the cabbages over a period of 50-56 days.

These experiments demonstrated that at an infestation level of 3 bugs per plant after 50-56 days, the crop yield was reduced by 38%, at an infestation level of 6 bugs per plant, by 75%, and at an infestation level of

12 bugs per plant there was complete destruction of the plant before the end of the experiment; 12 larvae (one egg batch) over the same period reduced the yield by 89% as compared with the controls (see Table 4). The results show a close agreement with those of Shapiro (1951).

Results, which were obtained from two summers' work in the fields of the Dzhambula "Kommunizm" State Farm, Syr-Dar'insk region and the Kzyl-Orda State Agricultural Experimental Station, show that the percentage infestation of white cabbage by bugs is very high. For example, in 1957, the mean infestation per hectare of "Number One" variety of early cabbage in the "Kommunizm" State Farm was 45-52%. In the Kzyl-Orda State Agricultural Stations's experimental field of 0.6 hectare more than 40% of the cabbages were infested in 1957.

Control measures. Our observations and results from the Kzyl-Orda region provide a basis for the recommendation of the following control measures:

1) It is recommended that in early spring the adult bugs should be collected from wild cruciferous plants before their mass breeding commences;

2) we have observed that the bugs hibernate under fallen leaves in gardens, in plantations of trees, and under old cabbage leaves; it is necessary, therefore, that such fallen leaves be collected and destroyed and the cabbage stumps with their associated leaves be destroyed in the fields.

We have made no particular study of chemical measures for the control of this pest. However, in 1957, students of the Institute carried out experiments on the destruction of bugs using 5 and 12% DDT powders; the results were favorable.

The author is deeply grateful to V. V. Yakhontov for his assistance with this research, to A. N. Kirichenko for his help in identifying species and to P. Polyakov for his identification of plants.

SUMMARY

In the Kzyl-Orda region (Kazakhstan) Eurydema wilkinsi Dist. was observed to be a destructive pest of cultivated Cruciferae (cabbage and radish).

Under the conditions of the Kzyl-Orda region the food plants of E. wilkinsi are exclusively Cruciferae.

In the Kzyl-Orda region E. wilkinsi has three generations annually.

The losses in the yield of cabbage depend on the density of the population of bugs. The estimated losses in yield caused by bugs were 38, 75 and 100% of the yield under the densities of three, six and twelve bugs per plant, respectively.

The estimated loss caused by twelve larvae (hatched from one egg-batch) per plant was 89%.

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THE BIOLOGY OF THE LARGE POPLAR LONGHORN SAPERDA CARCHARIAS L. (COLEOPTERA, CERAMBYCIDAE)

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The main problem confronting the author was to discover silvicultural methods against the large poplar longhorn (Saperda carcharias L.), which would check the increase in number of this species and would prevent new infestation of plantations. This necessitated a study of questions relating to the biology of the longhorn, since the information on it in the literature is rather contradictory.

The majority of authors (Cecconi, 1914; Shestakov, 1931; Grechkin, 1951; Cherepanov, 1952; Cramer, 1954, and others), who have devoted themselves to a study of the biology of the large poplar longhorn, have recorded a two-year generation for this pest; according to their information the development of the species can be outlined in the following way; flight of beetles in June-August, appearance of larvae, according to Cecconi, (1914), Shestakov (1931), and Cherepanov (1952), at the end of summer. Grechkin (1951) observed that some of the eggs overwintered. Cramer (1954) recorded the hatching of the larvae in April of the following year. Thus, according to Cecconi, Shestakov and Cherepanov the larva pupates in April-May after wintering twice while, according to Cramer, it winters once. In addition, Cramer observed a diapause in some larvae of the later instars.

Other authors indicated a more prolonged period of development. For instance, Ritchie (1920) and Strojny (1952) found a 4-year generation in Scotland and Poland. According to Strojny (1952), the developmental cycle of the longhorn proceeds in the following way: flight of beetles and oviposition in July-August, the eggs overwinter, the larvae hatch out in May and develop over a period of 36 months (wintering three times) pupation in May, beetles appear in June-July.

During 1955-1957 the author conducted research into the biology of S. carcharias L. in the Savala forestry (Voronezh, formerly Balashov, region; Savala Center of VIZR).

The observations and collections of larvae were carried out over a period of 3 years in the same marked-off areas. One of them (No. 1) was situated in a 30-year old pure poplar stand in good condition with 40-60% of the trunks infested with the longhorn and a density of about 2 larvae per trunk. The second (No. 2) was located in a stand of similar composition and age, but this was 80-90% infested, with a density of about 5 larvae per trunk, and with half the trunks dry or dry-crowned. The third (No. 3) was situated among thriving 3-year-old plants, more than half of which were infested with the longhorn. To determine the period of development of the longhorn, we opened up a certain number of trunks every month. We removed the larvae and measured the width of the head capsule, the body length and the weight. Altogether we measured 450 larvae, most of which belonged to the generation which emerged from eggs laid in 1955. Besides these indices we also determined the amount of fat and the respiratory coefficient, which was determined in Krogh's apparatus. The amount of fat was established by the Soxhlet method. A more accurate analysis of the fat deposits was obtained by histological treatment of the material. For this purpose larvae of all instars found in the field during this period were fixed in Bouin's fluid at three times (April, July and October). Staining was done with Heidenhain's iron hematoxylin. In order to find the limits of variation of the above-noted indices, we opened trees of different origin, condition and species at the same time.

TABLE 1

Relation between Size of Head Capsule, Body Length and Weight of Larvae in Each Instar

Age group	Width of head capsule (mm)						Body length (mm)						Weight (g)		
	Greatest size	Smallest size	Difference between greatest and smallest size	Most frequent size	Difference between most frequent size and greatest size	Difference between most frequent size and smallest size	Greatest size	Smallest size	Difference between greatest and smallest size	Most frequent size	Difference between most frequent size and greatest size	Difference between most frequent size and smallest size	Greatest	Smallest	Ratio of greatest weight to smallest weight
I	1.5	0.8	0.7	1.1	0.4	0.3	9	6	3	7	2	1	0.0274	0.0144	1.9
II	3.0	1.7	1.3	2.2	0.8	0.5	22	15	7	18	4	3	0.2675	0.0255	10.5
III	4.0	3.3	0.7	3.5	0.5	0.2	37	30	7	35	2	5	1.0213	0.5320	1.9
IV	4.7	3.9	0.8	4.2	0.5	0.3	40	30	10	35	5	5	2.2563	1.2139	1.9

The width of the head capsule was the main character used to separate the instars. Besides this, we also took into consideration the body length, weight and the nearness to completion of the larval gallery.

The results of the measurements made in the period 5/20 to 10/10, 1956 are collected in Table 1.

We see from this table that the least variation is found in the size of the head capsule. Deviations from the most frequent size do not exceed 0.5 mm. Hence, we settled on this character for the statistical treatment of the material. For our calculation, we used the method of sums due to Zdorik (1952) taking the most frequent sizes of the head capsule as the variants (x) and the number of measurements as the populations (n):

Instar I

			b_1	b_2
x_1	n_1	$x_1 n_1$	14	1
0.7	1	0.7	1	1
0.9	12	10.8	13	—
1.1	20	22.0	—	—
1.3	9	11.7	16	—
1.5	7	10.5	7	7
	49	55.7	23	7
			a_1	a_2

$S_1 = a_1 - b_1$;
$S_1 = 23 - 14 = 9$,
$S_2 = a_1 + b_1 + 2a_2 + 2b_2$,
$S_2 = 23 + 14 + 14 + 2 = 53$.

Arithmetic mean $-x$

$$x = \frac{\sum nx}{\sum n}; \quad x = \frac{55.7}{49} = 1.13.$$

Mean square $-\sigma$

$$\sigma = \pm \sqrt{\frac{S_2 - \frac{S_1^2}{\sum n}}{\sum n}};$$

$$\sigma_1 = \pm \sqrt{1.05} = \pm 1.02.$$

Error of mean m

$$m = \frac{\sigma}{\pm \sqrt{\sum n}};$$

$$m_1 = \frac{1.02}{\pm 7} = \pm 0.14.$$

Coefficient of variation $-v$

$$v = \frac{\sigma \cdot 100}{x};$$

$$v_1 = \frac{\pm 1.02 \cdot 100}{1.13} = \pm 81\%.$$

Instar II

x_2	n_2	$x_2 n_2$	b_1	b_2
1.7	13	22.1	50	13
1.9	24	45.6	13	13
2.1	33	69.3	37	—
2.3	21	48.3	—	—
2.5	19	47.5	56	—
2.7	10	27.0	35	57
2.9	6	17.4	16	22
	126	277.2	6	6
			113	85
			a_1	a_2

$$x_2 = \frac{277.2}{126} = 2.2,$$

$$\sigma_2 = \pm\sqrt{\frac{359 - \frac{63^2}{126}}{126}} = \pm\sqrt{2.5} = 1.58,$$

$$m_2 = \frac{\pm 1.58}{11.22} = \pm 0.14,$$

$$v_2 = \frac{1.58 \cdot 100}{2.2} = \pm 72\%,$$

$$S_1 = 63;\ S_2 = 359.$$

Comparing the arithmetic means and their errors for instars I and II, we obtain:

$$x_2 \pm m_2 = 2.2 \pm 0.14$$
$$x_1 \pm m_1 = 1{,}13 \pm 0{,}14$$
$$\text{Difference} = 1.07 \pm \sqrt{0.14^2 \pm 0.14^2} = 1.07 \pm 0.14.$$

Instar III

x_3	n_3	$x_3 n_3$	b_1	b_2
3.1	1	3.1	10	1
3.3	8	26.4	1	1
3.5	14	49.0	9	—
3.7	18	66.6	—	—
3.9	4	15.6	22	—
	45	160.7	4	4
			26	4
			a_1	a_2

$S_1 = 16,\ S_2 = 46.$

$$x_3 = \frac{160.7}{45} = 3.57,$$

$$\sigma_3 = \pm\sqrt{\frac{46 - 3.46}{45}} = \pm\sqrt{0.94} = \pm 0.97,$$

$$m_3 = \frac{\pm 0.97}{\pm\sqrt{45}} = \pm 0.14,$$

$$v_3 = \frac{0.97 \cdot 100}{3.57} = \pm 27\%$$

Comparing the arithmetic means for instars II and III, we obtain:

$$x_3 \pm m_3 = 3.57 \pm 0.14$$
$$x_2 \pm m_2 = 2.20 \pm 0.14$$
$$\text{Difference} = 1.37 \pm \sqrt{0.14^2 \pm 0.14^2} = 1.37 \pm 0.14$$

Instar IV

x_4	n_4	$x_4 n_4$	b_1	b_2
4.1	8	32.8	16	0
4.3	16	68.8	16	—
4.5	14	63.0	—	—
4.7	4	18.8	18	—
	42	183.4	4	4
			22	4
			a_1	a_2

$S_1 = 4,\ S_2 = 46.$

$$x_4 = \frac{183.4}{42} = 4.34,$$

$$\sigma_4 = \pm\sqrt{\frac{46 - 0.85}{42}} = \pm\sqrt{1.74} = \pm 1.32,$$

$$m_4 = \frac{\pm 1.32}{\pm\sqrt{42}} = \pm\frac{1.32}{6.45} = \pm 0.20,$$

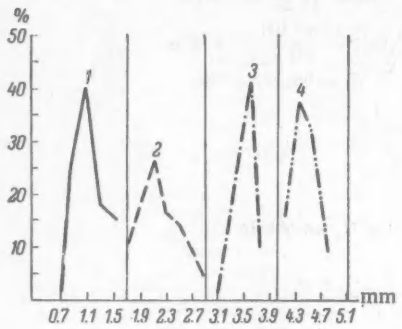
$$v_4 = \frac{\pm 1.32 \cdot 100}{4.34} = \pm 30\%$$

Comparing the arithmetic means for instar IV, we obtain

$$x_4 \pm m_4 = 4.34 \pm 0.20$$
$$x_3 \pm m_3 = 3.57 \pm 0.14$$
$$\text{Difference} = 0.77 \pm \sqrt{0.20^2 \pm 0.14^2} = 0.77 \pm 0.24.$$

These figures indicate that the width of the head capsule is a value definitely characterizing the instar, and that the observed deviations do not lie outside the limits of permissible errors.

Thus, the width of the head capsule increases by 1.07 ± 0.14 mm in instar II, by 1.37 ± 0.19 mm in instar III, and by 0.77 ± 0.24 mm in instar IV.



Variation of size of head capsule in each instar. 1) Measurements made in May-June, 1956; 2) in July and October, 1956; 3) in early June, 1958; 4) at end of August, 1958.

The results of the calculation are given in a graph (see figure). The vertical axis in the graph gives the number of measurements, which is expressed as a percentage of the total number measured in each larval instar and is named the frequency of occurrence. This conversion was carried out in order to equate the plotted curves and at the same time to preserve their individuality. The horizontal axis of the graph gives the variation in size of the head capsule, as found in nature. As a whole the graph forms a broken line with 4 peaks, which correspond to the four instars which we distinguished.

If we take into account the degree of completion of the larval galleries, the length and weight of the larvae, in addition to the size of the head capsule, we obtain 4 quite distinct age groups, which are characterized by the following features.

Instar I. Hatching of larvae at end of April and in May. The most frequent width of the head capsule in 1.1 mm, the body length 7 mm, the weight 0.0274-0.0144 g. The larva gnaws out a flat area under the bark. If this happens on young trees with a thin bark, a brown pollen-like frass is exuded. On trees with a thick bark the injury at this period does not have any external diagnostic features. Molting takes place in June-July. The duration of the first instar is 2 months.

Instar II. The most frequent width of the head capsule is 2.2 mm, the body length is 18 mm, the weight before wintering is 0.0255-0.0727 g, before molting to instar III it is 0.1430-0.2616 g. The larva begins to gnaw out a vertical gallery in the wood, in the surface layers to begin with, and then in the deeper layers. The length of the gallery reaches 10-15 cm, the frass is dislodged on to the surface, the length of its individual fibers being 0.2-0.4 cm. The duration of instar II is 12 months.

Instar III. The width of the head capsule is 3.5-4.0 mm; the body length 30-35 mm, the weight 0.5320-1.02132 g. The larva increases the length and width of the gallery, moves about freely in it, and before molting into instar IV bores a horizontal gallery up to the bark in the upper portion of the vertical gallery, for the emergence of the beetle. A coarse frass exudes at the surface, the length of its fibers 0.5-0.8 mm. The duration of instar III is 12 months.

Instar IV. The width of the head capsule is 4.0-5.1 mm, the body length 30-35 mm and the weight 1.2139-2.2563 g. The larva increases the length and width of the gallery, and by the end of summer it has prepared a pupal chamber in which it overwinters. It pupates in May, instar IV having lasted 10 months.

Thus, the total time for the development of the larva is 36 months. If we add to this time the wintering of the eggs and the pupation period, the complete development of the longhorn from egg to egg must take four years. The question arises: is this long span of development due to diapause in the later instars or is it natural to the species?

According to Cramer's results (1954), large larvae of length 2.8 cm (they must have belonged to our instar III larvae), removed from galleries at temperature −3°, did not become active when the temperature was gradually raised to 30° and at various humidities from 75 to 100%. Dissection of such larvae showed that they were quite healthy. For these reasons Cramer believed that the large larvae were in a state of prolonged diapause, as distinct from the small (1.8 cm long) larvae, which came out of cold torpor at temperature +5.5° and became inactive again when the temperature was lowered to −3°. The literature contains no other information on diapause in Saperda carcharias in the larval stage.

It must be noted that the diapause to which Cramer refers (1945), being found in the winter period (resting period), would not significantly affect the length of development if the larvae come out of diapause with the onset of spring. The length of the generation depends on the presence or absence of diapause in the period when the larva is developing rapidly. In this connection we carried out a series of observations on the life of larvae during the growing period.

On sampling area No. 1, we set up receptacles made from a piece of plywood in the form of a square, on which the frass from the gallery collected. The results of the weighings are collected in Table 2.

The results of weighings on 7/4 reveal the work of the larvae during the whole preceding growing period. On trunk No. 32 the gallery was bored by a larva hatched out in spring 1956 (instar I), on Nos. 81, 83 by larvae hatched out in 1955 (instar III), and on Nos. 36 and 50 by those hatched out in 1954 (instar IV). Beetles emerged from stems 36 and 50 in July 1957; their infestation had taken place in 1953.

TABLE 2

Results of Weighings of Frass Dislodged from the Larval Galleries

	Number of stem				
	№ 32	№ 36	№ 50	№ 81	№ 83
	Weight of air-dried frass (g)				
4 VII 1956	0.02	1.48	2.65	5.74	8.48
11 VII 1956	0.015	0.015	0.635	0.27	—
20 VII 1956	0.02	0.055	0.975	0.61	0.370
31 VII 1956	0.035	0.041	1.035	0.945	0.395

Since the dislodging of frass at the surface is one of the signs of normal development, we assumed that larvae were not in diapause when frass from the galleries accumulated. In addition, reliable indications that the larvae which would pupate in May in the case of a two-year generation, develop further without any pause, are the high respiration coefficient, varying between 0.75 and 0.85, and their increase in weight by 1.9 times during the period June-October (Table 1).

Histological examination of the material revealed that in the summer period there was a gradual accumulation of free fat and fatty-protein reserves in larval instars II, III and IV, both on drying and on healthy trees.

All the above facts indicate the absence of diapause in S. carcharias during the summer.

Thus, in the growing period the development of the larvae of all instars proceeds normally. We did not carry out any studies of larvae in the hibernation period, for the reasons mentioned above. During one growing period we could collect at one time either larvae of 3 different instars and eggs, or larvae of 3 instars and beetles, or larvae of 3 instars and pupae. Table 3 indicates this.

Figures enclosed in heavy lines characterize the 1955 generation larvae, which hatched out in spring 1956. From the above material we can assume that the emergence of adults of the 1955 generation took place in summer 1959, as is shown in Table 3.

The development of the longhorn in the conditions of the region studied is as follows: flight of beetles and oviposition in July-August; hatching of larvae in late April-May of the following year, larva lives 36 months; it first gnaws a gallery under the bark, then into the wood, prepares an exit opening for the bettle by tunnelling a horizontal gallery to the bark in the upper end of the vertical gallery, and before its last wintering it makes a pupal chamber in which it winters; pupation in May; emergence of beetles in July (Table 4).

Thus, some authors believe that S. carcharias has a 2-year generation, and others that it has a 4-year one. This would be possible if the investigations under discussion were carried out in different geographical zones. But the climatic conditions in the central zone of the USSR, Poland and Germany, where Grechkin (1951), Strojny (1952), Cramer (1954), the present author and others did their work, are so similar that we might surmise an equal or very similar length of development for the longhorn in these localities.

TABLE 3

Frequency of Occurrence of Developmental Stages of the Longhorn within One Growing Period and in Each Year

		Most frequent developmental state	Instar I					Instar II							Instar III					Instar IV					
			size of larval head capsule																						
			0.7	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.5	3.7	3.9	4.1	4.3	4.5	4.7	4.9	5.1
			number of measurements																						
1955	May-June	Larvae I, II, III, pupae	—	—	—	—	2	3	—	3	—	—	2	—	—	—	3	1	1	—	—	—	—	—	—
	July-October	Eggs, beetles, larvae II, III, IV					1	—	1	—	1	2	—	—	1	—	3	—	—	2	—	—	—	—	—
		Wintering																							
1956	May-June	Larvae I, II, III, pupae	1	12	20	9	5	3	—	—	—	1	—	—	3	—	3	—	—	4	—	—	—	—	—
	July-October	Eggs, beetles, larvae II, III, IV	—	—	—	—	10	13	23	33	20	17	10	6	7	5	6	1	2	5	4	6	2	—	—
		Wintering																							
1957	April-June	Pupae, larvae I, II, III	1	3	6	—	—	—	—	2	5	11	10	5	—	2	5	—	4	—	—	—	1	4	1
	July	Larvae II, III, IV, eggs, beetles	—	—	—	—	—	—	—	1	3	1	—	—	8	8	4	2	1	1	—	1	—	2	—
		Wintering																							
1958	May-June	Pupae, larvae, I, II, III	—	—	—	—	—	—	—	—	—	—	—	—	1	8	14	18	4	—	—	—	—	—	—
	July-October	Larvae II, III, IV, eggs, beetles	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8	16	14	—	4	—

As we know, the number of larval instars and the total length of development may vary according to weather and feeding conditions. The measurements of sizes and weights of the larvae, which we conducted over a period of 3 years on the marked-off areas described above, indicate that the number of larval instars in S. carcharias and the time for their development vary so slightly that they cannot so substantially alter the total time for one generation.

From the investigations we conducted on the problem of the length of development of S. carcharias we can agree with Strojny (1952) and consider that the idea of a 2-year generation for the longhorn is mistaken.

This error could have arisen because several years' observations were not conducted in the same locality. In addition, the following circumstance may lead the unwary into error: on opening up the galleries of the pest, we noted several times that a larva attacked by parasites made a pupal chamber before its death, where the parasite later pupated, and it also prepared an exit hole by tunnelling a horizontal gallery to the bark. Cherepanov (1948) gives similar information with regard to the larch longhorn, when attacked by Tachina.

Since Rhimphoctona fulvipes Holmgr., for instance, according to our observations, has a one-year cycle of development, the completed miniature galleries must be made by the instar II larva. The same picture was observed in the galleries of instar III larvae attacked by an ichneumon, the species of which we unfortunately could not determine from the larval stage. Thus the galleries from which the parasites emerge cannot be considered identical with the galleries from which the beetles emerged, since the first belonged to larvae which had not completed their development.

During the period of imaginal development when the beetle leads an open form of life, the requirements of the species become different.

Characteristic of the species is the protracted emergence of the beetles and their low numbers as compared with their numbers in the egg and larval phases. This is due to the great mortality among the larvae, particularly in instars I and II: for instance, the number of larvae of the 1955 generation on sampling area No. 1 fell during the course of the first year to one tenth (results of surveys of Aug. 3, 1956 and July 8, 1957).

After emergence the beetles rise into the crowns, where they do their supplementary feeding. Our observations on the supplementary feeding did not give any different results from the information available in the literature (Selishchenskaya, 1935, and others). The life span of the beetle is about 2 months. The period of supplementary feeding is not long. A week after emergence mating begins and on the 8-10th day the eggs are laid. Egg laying usually takes place during daylight. In each incision the female lays one egg and smears the incision with fluid. If the egg is laid under thin bark a swelling forms around it within a few days. If it is laid under thick bark no swelling can be seen. The females lay 50-60 eggs. We find a similar figure in Strojny's work (1952).

TABLE 4

Schematic Development of Saperda carcharias L.

	Months											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1st year						+++ ...	+++ ...	+ ...	...	...	...	...
2nd year	...	...	...	...	..	—	—	—	—	—	—	—
3rd year	—	—	—	—	—	—	—	—	—	—	—	—
4th year	—	—	—	—	—	—	—	—	—	—	—	—
5th year	—	—	—	— o	— ooo	+ oo	+++ ...					

Note: + beetle; . egg; — larva; o pupa.

During the egg-laying period the females continue to feed and mate during the morning and evening hours. Large numbers are on the wing (Cherepanov, 1952; Cramer, 1954) in twilight, before sunset. We did not manage to observe this happening, probably since the beetle population was not high.

Observations in the field, in the insectarium and in tests in temperature and light gradients showed that the beetles were photo- and thermophilous Stark (1954) indicates the same.

The information obtained on the biology of the longhorn enabled us to direct our investigations toward control measures in the form of silivicultural methods, these consisting of the introduction of bushes and other woody plants under the tree cover in existing plantations, in the creation of new plantations of the tree-shrub type and selective or entire sanitary clearings in localities where they are convenient.

Exterminative measures against the larvae, which live a concealed life, are of little effect and are very laborious, hence we do not recommend them. This question will be discussed more fully in another work which is at present in the press.

DISCUSSION

1. The developmental cycle of Saperda carcharias L. in the conditions prevailing in the Savala forestry lasts 4 years. The egg phase takes about 10 months, the larva – 36 months and the pupa – about 2 months.

2. Between hatching and pupation the larva passes through 4 instars. Instar I lasts about 2 months; on its conclusion the size of the head capsule of the larvae is 1.5 mm, their length is 9 mm, and their weight 0.0274 g; 0.0274 g; the larvae gnaw out a flat area under the bark. Instar II lasts 12 months; larvae of this instar have the following dimensions: width of head capsule 2.2 mm, body length 18 mm, weight before molting into instar III 0.2675 g; the larva bores a vertical gallery into the wood. Instar III also lasts one year; the dimensions of the larvae increase accordingly: head capsule to 4.0 mm, length 35 mm and weight 1.0213 g; before molting into instar IV and larva makes a horizontal gallery for the emergence of the beetle. In instar IV the head capsule increases to 4.5-5.9 mm, the weight to 2.2563 g. The larva prepares a pupal chamber in which it overwinters and it pupates in the spring of the following year.

3. There is no pause in development during the larval phase.

4. Larvae attacked by parasites prepare a pupal chamber and an exit hole before death, irrespective of the instar attained by that time.

5. In the imaginal phase this species requires heat and light. The emergence period is protracted. The beetles are sluggish. There are no great numbers on the wing at any particular hour of the day. Egg laying takes place in the daytime. The beetles feed and pair in the morning and evening

SUMMARY

This work is a part of a series of investigations devoted to the elaboration of new silvicultural methods of the control of Saperda carcharias L. as a pest of poplar. Some data on the biology of the larval and of the adult phases have been obtained.

The studies have been carried out at the Savala forestry (Balashov region). The duration of the entire life cycle of S. carcharias in this region was observed to be four years. The egg phase requires about 10 months; the larval and pupal phases last about 36 months and 2 months respectively. There are four larval instars. The is no pause in the development during the larval phase. A larva infested by a parasite before its death prepares a pupal chamber and an emergence hole, irrespective of the instar attained by that time. The adult beetles are photo- and thermophilous. They are rather sluggish. The period of emergence is protracted.

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THE BIOLOGY OF THE GALL MIDGE KALTENBACHIELLA STROBI WINN. (DIPTERA, ITONIDIDAE) INJURIOUS TO SPRUCE CONES

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In an investigation of insects damaging the cones and seeds of spruce in south Karelia, our attention was turned on the spruce cone gall midge (Kaltenbachiella strobi Winn.).* The reason for the study of this midge were its wide distribution, the lack of research into its biology, and the presence of many parasites.

During observations in 1952 and 1953 this gall midge was found in almost every spruce cone, being an ever-present associate of the cone pyralid (Dioryctria abietella Schiff.) and the cone tortrix (Laspeyresia strobilella L.).

A study of the biology of this species presented some difficulty since, besides the above-mentioned gall-midge (Kaltenbachiella strobi Winn.), the spruce cones were inhabited by the spruce seed midge (Plemeliella abietina Seitner), and also another gall midge which, as we found out later, was, according to P.I. Marikavskii, a new genus of the tribe Porrycondylini.

The published information of a number of authors (Stark, 1931; Berezina and Kurentsov, 1935; Florov, 1951) does not give an adequate picture of the biology of gall midge or, in particular, of their economic significance.

Our two years' observations were carried out in the type of forest commonest in south Karelia – spruce-bilberry forest – both in plantations and in cutting areas, among areas of thinned spruce saplings, and we also examined fallen cones (windfalls) under the crowns of individual trees in the plantations.

In the treatment of each batch we cut open the cones and counted those which contained gall-midge cocoons; we determined the yield of seed from these cones, their absolute weight, their germinating ability and energy.

To establish the species of parasites of the gall midges we bred out the chalcids from gall-midge cocoons which had been removed from the galls formed inside the scale; in addition, some of the cones were put singly into paper packets for the same purpose.

When the adult insects appeared, we determined the contents of the packets and established to which host the emerged parasites belonged.

Some of the cones which were used to establish the times of development of the gall midge and its parasites overwintered in field conditions in open insectaria and were kept there throughout the whole period of investigation. The insects from this batch of cones were picked out by means of a light trap and were counted daily.

* Kaltenbachia strobi, Cecidomyia strobi, Perrisia strobi and Dasyneura strobi are synonyms of Kaltenbachiella strobi Winn.

The first appearance of the gall midges in the field coincided with a considerable warming of the air, when the day temperature in the shade rose to 20-24°. In the cooling period, when the temperature fell to 8 10°, the rate of emergence of the gall midges was appreciably reduced.

According to our 1953 observations the flight of the gall midge in the field occurred between May 15 and June 15. In the first ten days of June, which coincided with the mass emergence of the gall midges into the light trap, wesucceeded in capturing several specemins of gall midges in the field, round the crowns of isolated spruces. The flight took place at 5 o'clock in the evening in mild windless weather.

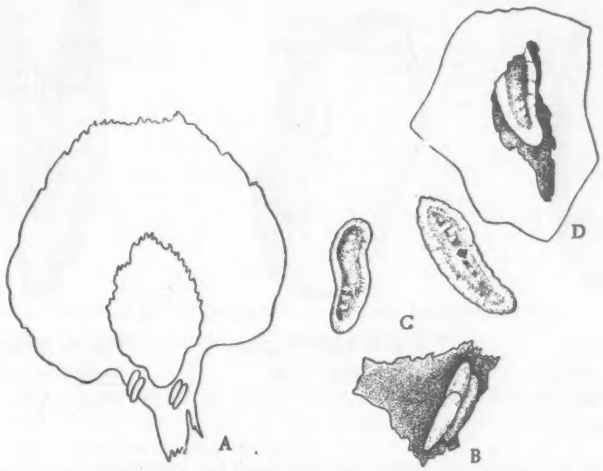

Fig. 1. Kaltenbachiella strobi Winn. A and B) Egg batches; C) first-instar larvae; D) larvae starting to penetrate into scale.

Among the gall midges which we obtained there was a large predominance of females, which proceeded to copulate 3-4 hr after emergence and laid their eggs on the young spruce cones lining the bottom of the cage.

The length of life of the adult gall midges (laboratory observations) when unfed, or fed with glucose, did not exceed 4 days.

The egg batch of the gall midge contains 1-2, rarely 3, eggs cemented together, and is usually placed on the inner side of the base of the scale of a young cone. The eggs are elongate, transparent, and become opaque shortly before the emergence of the larva.

The young larva has a transparent body with a clearly visible gut shining through, but gradually becomes darker with age and acquires an orange color. Immediately after hatching the larva begins to feed on the soft tissue of the scale, and then, by making a small deep pit, penetrates inside it (Fig. 1).

Scales which contain larvae do not change in external appearance, and it is not until later that the galls indicating the presence of the gall midge are formed on the inner side of the scales.

According to our observations, cone scales in the middle of July had already developed galls inside which were the white cocoons containing the larval gall midges. The mean size of the galls was 4 × 2 mm, the cocoons 3.7 to 5 mm, and the larvae (material in alcohol) 3 to 3.3 mm.

The galls were not restricted to any particular part of the scale, but in most cases they were found on the inner side of the scale close to its base. Pupation of the larvae takes place inside the gall in the following spring; the size of the pupa is 2 to 3 mm (Figs. 2, 3 and 4).

We should note that the illustration of the pupa of Kaltenbachiella (= Perrisia) strobi Winn. given in Holste's work (1922) does not correspond to the pupa of this species.

The density of infestation of cones by the gall midge was not uniform. According to our observations, 30 individuals on the average emerged from one cone, and only in a few cases, as a maximum, did we obtain up to 50 individuals (Fig. 5).

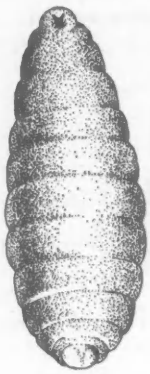

Fig. 2. Kaltenbachiella strobi Winn. Larvae before pupation.

Fig. 3. Kaltenbachiella strobi Winn. Cocoon.

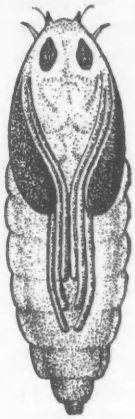

Fig. 4. Kaltenbachiella strobi Winn. Pupa.

In the work of Berezina and Kurentsov (1935) they indicated that one spruce cone may contain up to 17 pupae of K. strobi. According to other results (Eide, 1927), the number of pupae of this gall midge might reach 200.

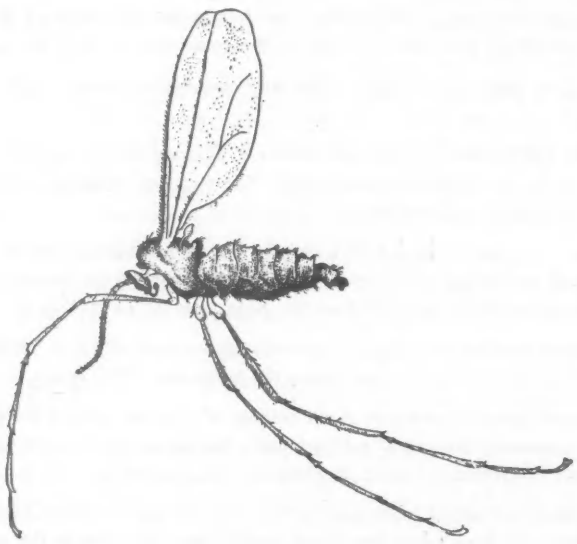

Fig. 5. Kaltenbachiella strobi Winn. Adult insect.

According to our observations, a somewhate larger number of gall midges was observed on scattered groups of well-lit spruce saplings left behind in felled areas. Here the infestation of the cones was one and a

a half times greater than in the adjacent stands which had not been affected by the cutting. In the work mentioned Berezina and Kurentsov noted that gall midges were commonest in spruce-Polytrichum forest.

Florov (1951) refers to the finding of this gall midge in Tunka valley in the Buryat-Mongol SSR at a height of 1200 m above sea level.

TABLE 1

A Qualitative Characterization of Spruce Seeds from Cones Damaged by the Gall Midge

Category of cones	Yield of seeds (in g per cone)	Absolute weight of seeds	1952		1953	
			germinating energy (in %)	germinating ability (in %)	germinating energy (in %)	germinating ability (in %)
Undamaged cones	0.25	2.20	59	74	36	45*
Damaged by gall-midge (containing 50 pupae each or more)	0.07	2.04	10	54	29	33

*The relatively low germinating ability of seeds from undamaged cones in 1953 was due to the unripeness of cones collected in September.

According to our 1953 results, out of 1050 cones examined there was not one free from gall-midge pupae. In the category of cones damaged by the gall midge we included cones which contained at least 50 pupae. Such cones comprised 7% of the number examined (1050).

The yield of seeds from these cones and the results of testing their germinating ability and energy* are given in Table 1.

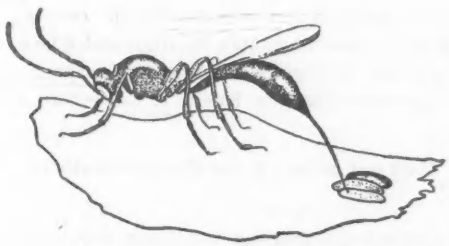

Fig. 6. Female egg parasite (Diaphrina sp.) laying eggs on the egg batch of the gall midge.

We see from this table that the presence of the gall midge in cones appreciably lowers the seed yield, and affects their absolute weight and germinating ability, which are also appreciably reduced as compared with the same indices for seeds of undamaged cones.

An examination of the insects in packets containing cones infested with the gall midge enabled us to establish the numerical relationships between the gall midge and its parasites, and also the relationships between the species of parasites themselves (Table 2).

The principal, most abundant enemies of the gall midge were found to be chalcids Calimome azureum Boh. (family Callimomidae) and Diaphrina sp. of the family Proctotrypidae.

In the middle of June, we succeeded in observing under the binocular the attack of Diaphrina on the laid eggs of the gall midge (Fig. 6). We found that from eggs attacked by this parasite there emerged gall-midge larvae, in which the development at first was normal. In the September cones we could see the brownish, slightly transparent cocoons of the parasite, containing the fully formed parasites, which overwintered in the cones. As regards the gall-midge larvae, they winter in white leathery cocoons and do not pupate until spring.

Less common parasites of the gall midge were the chalcids Anogmus strobilarum Thoms. and Eutelus

*"Germinating energy" – a measure of the ability of seeds to germinate simultaneously. Translator.

piceae Ruschka. We obtained these two species, like those mentioned above, from cones enclosed in packets, and also from individual gall-midge cocoons especially picked out from the galls.*

From the number of insects obtained from the three batches of cones (Table 2) we can conclude that there is a considerable predominance of parasites of the gall midge in cones taken from the plantations. The total number of parasites there was more than twice the number of gall midges which emerged. A particular case of this was the batch of fallen cones, where the number of parasites obtained was more than ten times the number of gall midges which emerged.

TABLE 2

Relationship between Numbers of Emerging Gall Midges and Their Parasites

Place of collection of cones	No. of cones examined	No. of emerged gall-midges	Number of parasites				
			Total number	including			
				egg parasites *Diaphrina* sp.	*Callimome azureum* Boh.	*Anogmus strobilarum* Thoms.	*Eutelus piceae* Ruschka
Groups of spruce sapling	20	360	231	104	100	13	14
Plantation unaffected by felling	20	211	516	108	266	125	17
Fallen cones	20	55	570	68	414	68	20
Total	60	626	1317 abs.	250	750	206	51
			1317 in %	24	57	15	4

The flight periods of the adult entomophages in the field, according to our 1953 observations were as follows: the egg parasite (Diaphrina sp.) – flight commenced May 12, mass flight May 25, flight ended June 13; Callimome azureum – flight commenced June 12, mass flight June 17, flight ended June 27; Anogmus strobilarum – flight commenced June 17, mass flight June 24, flight ended June 28; Eutelus piceae – mass flight June 24.

The flight of the gall midge started on May 15, the mass flight was on June 9, and the flight ended on June 15.

The presence of the parasites Callimome azureum, Eutelus piceae and Anogmus strobilarum on Kaltenbachiella strobi has also been recorded for the forests of Bavaria (Holste, 1922).

In conclusion I express my thanks to V. Ya. Shiperovich for valuable advice on questions of method and for identifying the chalcids, and also to P. I. Marikovskii for help in determining the species of the gall midge.

SUMMARY

Kaltenbachiella strobi Winn. is a common pest of spruce cones in the forests of southern Karelia. Its life cycle is closely adapted to the phenology of spruce and to the phases of development of cones.

K. strobi infests spruce cones in mass quantities being usually associated with the moths Dioryctria abietella Schiff. and Lasperesia abietella L. Occasionally however K. strobi was observed to infest a cone alone, not concomitantly with other insects. Heavy infestation results in considerable losses in the yield of seeds as well as in the decrease in weight and germinating quality of seeds.

Among the natural enemies of K. strobi the most important and the most common are Callimome

*Only one individual of the parasite develops in the gall-midge larva attacked.

azureum Boh. (Callimomidae) and the egg parasite Diaphrina sp. (Proctotrupidae).

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THE BIOLOGY OF THE HAWTHORN SPIDER MITE TETRANYCHUS CRATAEGI HIRST (ACRAIFORMES, TETRANYCHIDAE)

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As a result of the extensive use of DDT and other organic insecticides in recent years there has been an increased multiplication of tetranychid mites on various crops. A particularly serious situation has been created in apple and plum orchards in the principal commerical fruit-growing regions both in our own country and abroad.

The large-scale multiplication of tetranychid fruit mites, the vast damage which they cause to the fruit-growing industry, and the lack of research on this group of pests made it essential to determine the species of mites involved, to study the biology of the most important species and to seek the most effective methods of preventing their harmful activity.

The author of the present paper made an attempt to tackle these question in the case of the conditions prevailing in Krasnodar territory.

Special investigations of the apple orchards in Slavyanskaya, Krasnoarmeiskaya, Temryuk, Gelendzhik, Tuapse, Lazarevskoe and Adler regions of Krasnodar territory were carried out in order to discover the species of mites involved. The results of these investigations, and also the collections of mites which I had at hand from Belorechenskaya, Krymskaya, Maikop and Sochi regions, revealed that on apple trees in Krasnodar territory there occurred 5 species of tetranychid mites, belonging to 3 familes: family Bryobiidae – 1) Bryobia redikorzevi Reck (the brown fruit mite); family Tetranychidae – 2) Tetranychus crataegi Hirst (the hawthorn spider mite), 3) Tetranychus tetraius (L.) (common spider mite), 4) Metatetranychus ulmi (C.L. Koch) (red apple mite); family Tenuipalpidae – 5) Brevipalpus geisenheyneri (Rubsaamen) (the flat-bodied garden mite).

Four years (1954-1957) of research on the development of tetranychid mites and of population surveys of these pests showed that the main species damaging apple were B. redikorzevi and T. crataegi, which were found in all the investigated regions. M. ulmi was found only in the regions of the costal zone (Gelendzhik, Tuapse, Lazarevskoe, Sochi and Adler), where it damaged fig, and sometetimes apple and plum. The mites T. telarius and B. geisenheyneri, though common and widespread species in the territory, did not have any practical significance for fruit trees, owing to the very small numbers of these mites. Hence, besides examining the effect of chemical treatment on the population variations of tetranychid mites, we also gave a great deal of attention to a study of the biology of B. redikorzevi and T. crataegi. Research on the other species was confined to phenological observations and population surveys. The information on the effect of chemical treatment has already been published (Beglyarov, 1957). A fairly detailed account of the biology of B. redikorzevi has been given in the work of several of our own and foreigh investigators (Bagdasaryan, 1952; Vereshchagina, 1953; Livshits, et al., 1954, 1956; Skripinkova, 1954; Böhm, 1954; Mathys, 1954, and others). The development of this pest in the conditions of Krasnodar territory is similar in general features to that in other regions of its occurrence, and hence it is not worthwhile to give an account of the biology of B. redikorzevi here.

The present paper is devoted to the biology of the hawthorn spider mite, a species which has received little study and which has not been studied at all in Krasnodar territory.

The research work on the biology of this pest was conducted during the period of postgraduate work in the All-Union Institute of Plant Protection under the guidance of the Head of the Laboratory of Biological Methods, Candidate of Agricultural Sciences, V. A. Shchepetil'nikova.

METHODS

The experimental part of the work was carried out in field station conditions at Slavyanskaya Center in 1954-1956, and in the Lazarevskaya insectarium of VIZR in 1957.

The biology of T. crataegi was studied by rearing mites individually in field and laboratory conditions. In addition, phenological observations were made of the development of the pest in the fruit orchards.

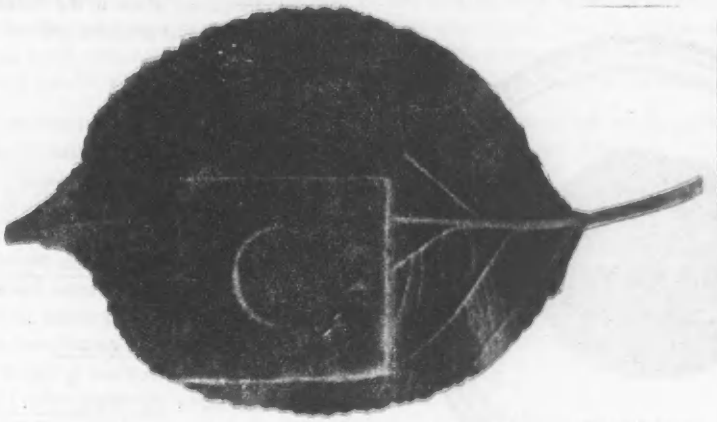

Fig. 1. Open felt container for rearing tetranychid mites in natural conditions.

In studies of the life span and fecudity in 1954 the mites were kept on young apple-tree leaves which were isolated by "nondrying" glue on the petiole. This method required a great deal of time for the daily observations, and was still not absolutely reliable owing to the activity of the mites. For instance, egg-laying females which had deposited eggs on one portion of the leaf, often moved to another spot, where they continued to feed and lay eggs. This behavior of the females made it necessary to examine the whole area of the leaf lamina on both sides at each inspection. In this case a few freshly laid eggs could be overlooked. In view of this, a different method was adopted from 1955 onwards, a hitherto undescribed method which ensured greater accuracy of observation and was much less laborious. In this method the mites were reared in special containers attached to the leaf (Fig. 1). White felt and x-ray film freed from the emulsion were used for the construction of the containers. The emulsion had to be removed so that the film did not heat up in the sunlight. If this had not been done, unusual conditions of increased temperature might have been created in the container. This was also the reason for using white-colored felt. For the construction of the containers the felt and film were cut into squares of side 2.5 cm. One of the squares of film was left entire, while a round hole of diameter 1.25 cm was made in the center of the other and in the felt square by means of a special borer. The felt square was then laid on the underside of the leaf lamina, followed by the square of film with the round hole. The whole square of film was laid on the upper surface of the leaf lamina. After this the film, felt and the leaf lamina held between them were stitched together at two points by means of a thread and an ordinary sewing needle. The stitching had no noticeable effect on the vital activity of the leaf, which remained perfectly suitable for the feeding of the mite for a month or more. Containers constructed in this way were used for individual rearing of mites in natural conditions. Thanks to this arrangement only the portion of the leaf bounded by the circular opening had to be examined, instead of both sides of the whole leaf lamina. It should be noted that when we are dealing with mites which migrate into the crown during the day (B. redikorzevi) it is necessary to deposit a narrow strip of nondrying glue around the circular opening of the container to prevent the mites crawling out.

In the laboratory the mites were kept in open glue-ring containers. For this purpose a disk of filter paper (4-5 layers) was placed in a Petri dish and thoroughly moistened with water. Freshly plucked green apple leaves, on which it was intended to rear the mites, were laid on the filter paper. A fine ring of nondrying glue was then deposited on the leaf lamina by means of an ordinary medical syringe with the needle removed. The area bounded by the glue barrier was in fact an open container (Fig. 2). The drawback of this method was the necessity for frequent (once every 3-4 days) change of the leaves carrying the glue-ring containers, since the mites tried to leave wilting leaves and were caught in the glue. The employment of this method, however, enabled us to follow the life cycle of the mites and was very convenient for observation.

In the individual rearing of mites in field and laboratory all the observations on the development of the mites were made twice a day at the same times (7. A.M. and 7 P.M.). During these observations, we noted all the changes taking place in the mites (rest, molting, color changes, etc.) and counted the number of eggs laid by the females.

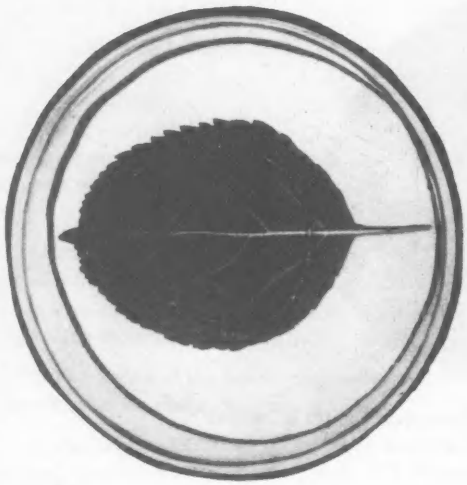

Fig. 2. Open glue-ring container for rearing tetranychid mites in the laboratory.

Synonymy

The hawthorn spider mite (T. crataegi) was first described by the English acarologist Hirst in July, 1920 from specimens collected on a hawthorn hedge. In September of the same year this species was described under the name of Tetranychus (Epitetranychus) viennensis by the acarologist Zacher from specimens collected near Vienna and in Berlin on apple, cherry, Prunus acida and Prunus avium var. In 1937 this same species was twice described by Ugarov as a new species under the names of Apotetranychus virginis and A. longipennis from apple in Samarkand and pear in Tashkent.

Distribution and Crops Damaged

In Krasnodar territory the hawthorn spider mite is a serious and generally distributed pest of apple and plum. More than once we also observed serious damage to pear trees. Among the other plants damaged by this pest we can name alycha (Prunus divaricata Led.), blackthorn (P. spinosa L.), sour cherry (Prunus cerasus), sweet cherry (Prunus avium), peach, apricot and hawthorn. In addition, mites of this species collected on oak and Persian walnut. Specimens of this species were also found on weed (convolvulus etc.) growing in the orchards, but these were incidental and not normal food plants.

As regards other regions of the Soviet Union the presence of the hawthorn spider mite had been reliably established in Transcaucasia, where it damages apple and certain other fruit trees (Rekk, 1949; Batiashvili and Bagdavadze, 1951), in Moldavia (Vereshchagina, 1954; Gontarenko, 1954; Vereshchagina and Vereshchagin, 1955), in the Ukraine (Dyadechko, 1954; Livshits et al., 1955, 1956, 1957), in Central Asia (Ugarov, 1937; Ugarov and Nikol'skii, 1937; Lindt, 1956) and in Kazakhstan (Vainshtein, 1954).

Abroad this species has been confirmed as a pest of apple, pear and certain other fruit crops in France (Bouron, Perrot, 1954; Chaboussou, Bessard, 1954; Rambier, 1954), and in Germany and Austria (Zacher, 1920, 1925; Roesler, 1951, 1953). According to the data of the European Plant Protection Organization (1954), T. crataegi is of economic significance as a pest of apple, pear and peach in France, and of apple in Germany.

Nature of Damage

The damage done by the hawthorn spider mite is manifested in different ways by the various kinds and varieties of fruit trees.

Usually the mite colony is located on the underside of the food-plant leaf, which is usually wreathed in gossamer. All the active mites secrete a web. Under the protective web the pest feeds and multiplies. In feeding

the mites pierce the leaf tissue with the long stilleto-like bristles of their oral apparatus and suck the cell sap. Small pale spots form at the sites of puncture, and these spots later merge together. As a result the damaged leaves of apple lose their fresh color, becoming a dingy greenish grey at first, and turning yellow and finally brown. The leaf tissue bulges out on the opposite side of the leaf from the colony and rapidly dries up. The leaf is often drawn together by gossamer in the form of a small boat along the midrib, where the mites are very partial to dwelling. When the mites develop in abundance there is a premature (in August-September) falling of the leaves. In the early spring period the mites attack the leaflets in the opening buds and cause them to dry up.

The picture of damage of plum of the Italian Vengerka variety is approximately the same as on apple. In the Reine Claude Brown and Persikovaya varieties of plum and in alycha the leaves become chlorotic as a result of the mites' feeding; they acquire a marble color, and by mid-August turn very yellow and begin to fall. Badly damaged apple trees can easily be recognized by the typical general sun-scorched appearance of the foliage, and in the case of alycha, by the marked yellowing of the great mass of the leaves.

According to our observations the hawthorn spider mite causes particularly serious injury to the following apple varieties: Simirenko Rennet, Champagne Rennet, Wagner and White Rozmarin.

The yield of the injured trees is lower than that of the undamaged trees. The fruit from injured trees are smaller and have a lower sugar content. This has been shown experimentally (Vereshchagina and Vereshchagin, 1955).

Thus, the damage caused by the hawthorn spider mite consists in a lowering of the assimilative capacity of the leaves, injury to the buds and a reduction in the quantity and quality of the crop. Repeated infestation by mites year after year results in a general deterioration and weakening of the plants.

Description of Developmental Phases

The egg is spherical, pale yellow to yellowish pink in color, usually cemented to the web, but sometimes laid directly on the leaf surface. Before the larva hatches, about half of the egg turns pale. The egg membrane is very fine. For this reason the eyes of the larva can be seen as 2 bright red dots shining through the membrane several hours before hatching. The diameter of the egg is 0.15 mm.

Larva. The newly hatched larva is round in form, slightly pointed at the hindend. The body color is pale yellow. As the larva grows the form of its body approaches an oval, and the coloration becomes different shades of green as feeding progresses. There are 3 pairs of legs. The length of the body is 0.18 mm, and the width 0.10 mm.

The nymph differs from the larva in the elongate-oval form of the body and, like the adult mite, has 4 pairs of legs. Nymph I (protonymph) can only be reliably distinguished from nymph II (deutonymph) by the number and disposition of the setae on the ventral side of the body (Rekk, 1949a).

Male. The body is rhomboid, converging sharply toward the hindend. The coloration is the same as in the younger stages, but there is often a yellowish tinge. The dorsal setae are long and pilose; their length is approximately twice the distance between the rows. The club of the chaetophore is roundly conical, approximately half as long as the spindle. Empodium 1 has 2 very thick bristles, from the base of which arises 1 or 2 very reduced slender bristles. Empodia II-IV are split into 3 pairs of long, almost equally slender, bristles. The penis has a very distinct hook bent almost at a right angle. The proximal outgrowth of the bilateral tuft is very tiny, scarcely distinguishable; the distal outgrowth is long and directed obliquely upwards. The body is 0.31 mm long and 0.18 mm broad.

Female. The body is ovoid, converging slightly posterad, spindle-shaped. The 24 pairs of dorsal setae are arranged in 6 transverse rows (2 + 4 + 6 + 4 + 4 + 4). The terminal elbow of the peritreme is split into strands, which together form a distinct reticular figure. The club of the chaetophore is roundly conical, broad. The spindle is as long as the club. Tarsi of legs I bear 2 macrochaetae, of which the anterior one is slightly shorter than the tarsus. Empodium of all legs split into 3 pairs of long bristles. The body is 0.54-0.60 mm long and 0.32-0.36 mm broad.

Peculiarities of coloration of females. It has been found that there exist 3 types of T. crataegi females, which differ in nature from one another. With sufficient familiarity, females can be fairly easily distinguished by the coloration of the body:

1) young females which have not yet proceeded to lay eggs – body color greenish yellow or yellowish red;

2) egg-laying "summer" females – body color dark red, often almost claret, sometimes with a slight violet hue;

3) "winter" females – body color bright red.

Biology

The fertilized females overwinter under dead bark, in trap bands, in the pupal shucks and empty cocoons of various insects which pupate on the trunk. The greatest number of overwintering mites are concentrated on the stem at a height of up to 1 m from the soil surface. A very small number of overwintering females are found in the surface layer of soil and under fallen leaves. In the hibernation sites the females collect in small colonies or in vast numbers, several hundreds or even thousands on one square centimeter of the surface occupied. When large numbers of mites are concentrated in one spot they are arranged in several layers. Colonies of wintering mites are situated under the cover of a fine pale white web. Lindt's (1956) claim that in Tadzhikistan the mites collect for hibernation in small groups of 5-20 individuals, usually forming one layer, seems doubtful to us and to require verification. We are also dubious about the same author's claim that the hibernation sites are not covered with web.

It should be mentioned that the finding of overwintering mites does not represent any great difficulty owing to their bright red coloration.

The times of emergence of the mites from their hibernation sites depends on the temperature conditions in spring. For instance, in Slavyanskaya, in the cold and protracted spring of 1954, the first overwintered females were found on leaves in the first ten days of May. In 1955 and 1956, when the spring was warmer and shorter, the mites had already begun to leave their hibernation sites by mid-April. The emergence of mites from their hibernation sites was a lengthy process, lasting more than a month, approximately up to the end of the apple blossom. The first females, which settled in the crown, fed on the young leaves in the opening buds. Later the mites transferred to the leaves, where they continued to feed, and after that proceeded to oviposition. In spring the females laid their first eggs 15-20 days after their migration into the crown from the hibernation sites. Owing to the protracted period of emergence from the hibernation sites and the long period of egg-laying the generations overlap, and during the summer all phases of development of the pest can be found.

A study of the biology of the hawthorn spider mite by individual rearing on leaves of experimental apple trees enabled us to establish that the development of one generation of the pest in natural conditions is completed in 12-19 days. The observations on the development of the mites were made in 1954 from July 20 to the end of September, and in 1955 from June 11 to the end of September. The results of these observations are given in Table 1. In 1955, before the setting-up of special experiments to find out the times of development of the mite, the observations were made in the field in the orchard of the M. Gor'kii "Sad-Gigant" State Farm. It was found that two generations of the pest developed between the time of emergence from the hibernation sites and June 10. From June to the end of September (by this time most of the pests had migrated to their hibernation sites) there developed another 6 generations of mite; the females which appeared in late September and early October migrated to their hibernation sites without laying eggs. Thus, in the conditions prevailing in Slavyanskaya the hawthorn spider mite gives 8 full generations and a partial 9th.

The development of the bulk of the pests does not begin till the second half of summer, when the dry and hot weather sets in. Hence the hawthorn mite supplements, as it were, the damage caused by the brown fruit mite which develops in largest numbers in the first half of summer. There are indications to the effect that the mass development of the hawthorn spider mite does not take place till midsummer in the Crimea (Livshits et al., 1955, 1956) and Tadzhikistan (Lindt, 1956) and abroad, on the Mediterranean coast of France (Rambier, 1954).

In the conditions of the flood-plain fruit-growing subregion of Krasnodar territory (Slavyanskaya) the first "winger" bright red females of 1954-1956 were recorded in the very last days of July, while in the costal zone (Lazarevskoe) in 1957 they were recorded in early August. In the first ten days of September the females left the crown in large numbers and migrated to thier hibenation sites. At this time, if the mites had developed in large numbers, fairly large bright red spots, constituting vast colonies of females assembled for hibernation, could be found under loose bark on the trunk. Where trap bands had been put on the trees, they were packed with wintering mites. However, despite the vast number of the pest in summer and autumn, they were extremely scarce in the spring period and could only be found with difficulty. This was due to the large-scale mortality among the mites in the late autumn and winter period. In this connection the recommendation of certain authors (Vereschagin, 1954) that the destruction of the dense concentrations in the hibernation sites might be adopted as one measure of controlling the hawthorn mite seems to us to be ineffective and inadvisable.

TABLE 1

Development of the Hawthorn Spider Mite in Natural Conditions (Slavyanskaya)

Times of development of mite generation		Mean daily air temperature during observations (in °C)	Mean R.H. of air during observations (in %)
calendar	in days		
1954			
20 VII–1 VIII	12	23.4	75.4
1 VIII–14 VIII	13	23.6	74.3
14 VIII–1 IX	18	22.1	73.3
1 IX–females, without laying eggs, assumed their winter coloring			
1955			
11 VI–25 VI	14	21.0	67.6
25 VI–9 VII	14	22.2	70.5
9 VII–23 VII	14	23.7	67.3
23 VII–8 VIII	16	20.8	72.0
8 VIII–25 VIII	17	21.7	69.2
25 VIII–13 IX	19	19.6	63.2
13 IX – females, without laying eggs, assumed their winter coloring			

TABLE 2

Development of the Hawthorn Spider Mite in the Laboratory (Slavyanskaya, 1955)

Development phases	Duration of development (in days)
1) Egg	4—5
2) Larva	1—2
3) Premolting rest	0.5—1.5
4) Protonymph	1.0—1.5
5) Premolting rest	1.0—1.5
6) Deutonymph	1.5
7) Premolting rest	1.0—1.5
8) Ripening of females	1.0—5.0
Altogether	12.0—18.5

It should be noted that although most of the mites have already migrated to their hibernation sites by the end of September, a few individuals can still be found on the leaves right up to November 15-20.

In the laboratory, where the mean daily temperature varied between 22.5 and 25°C, we managed to follow in fair detail the life cycle and duration of the developmental phases of the mite. The result obtained are given in Table 2.

It can be seen from the data of the Table that at the temperatures mentioned above, the development of the egg takes 4-5 days, the larva 1-2 days, the protonymph 1-1.5 days and the deutonymph 1.5 days. Change from one instar to another is accompanied by a molt, which is preceded by a special state of premolting rest. The premolting rest lasts 0.5-1.5 days.

In the course of this experiment, and also in the rearing of mites from individual eggs laid by fertilized and unfertilized females, it was found that males of this species, as also the females, molted 3 times during their development. The claim by Livshits et al. (1955, 1956) that males of the hawthorn spider mite pass into the adult state directly from the protonymph is, in our view, incorrect.

Our experiment confirmed the existence of parthenogenetic reproduction in mites of this species. Here, as in other species of the genus Tetranychus, the eggs laid by unfertilized females produce only males, while eggs from fertilized females produce both males and females.

It was found that in summer the body color of young females gradually changed to dark red as they continued to feed and then they proceeded to lay eggs. At the end of summer and in autumn some of the females changed, as in summer, into egg-laying females, while others changed color to bright red and migrated to their hibernation sites. The females which proceeded to lay eggs did not overwinter and perished with the onset of cold weather. The bright red females which would migrate for hibernation did not lay eggs that year, although they might remain to feed on the leaf for several days.

Fecundity and length of life of females. By rearing individual "summer" females of the hawthorn spider mite on leaves of experimental apple trees in natural conditions we investigated their egg laying and length of life. The results of these observations are given in Table 3.

TABLE 3

Length of Life and Egg-Laying Period and Fecundity of Female Hawthorn Spider Mite (Slavyanskaya)

Indices	Mean		Maximum		Minimum	
	1954	1955	1954	1955	1954	1955
Length of life (in days)	30	28	36	44	18	17
Length of egg-laying period (in days)	27	25	34	41	16	13
Number of eggs laid	70	82	96	133	42	44

Note: In 1954 during the period of observations the mean air temperature was 20.9°C (17.2-25.4°), the mean relative humidity was 72% (52-90%). In 1955 during the period of observations the mean air temperature was 23.1° (20.4-27.6°), and the mean relative humidity 73% (50-92%).

It can be seen from Table 3 that females of the hawthorn spider mite laid an average of 70-82 eggs during a life lasting 28-30 days on the average. The females did not proceed immediately to lay eggs after their final molt, but only after a certain period, during which they fed and changed color (1-5 days in our experiment). When the last egg had been laid the females either perished immediately, or continued to live and feed for some time longer. We observed one female which survived 16 days after laying its last egg, but they usually perished on the 2nd-6th day. In our experiments the number of eggs laid by one female per day did not exceed 8.

Summarizing the foregoing account we note that owing to its short time of development and its high fecundity the hawthorn spider mite is able to attain high numbers in a relative short period and to inflict serious damage on fruit trees.

SUMMARY

Among the tetranychid mites living on apple trees and other deciduous fruit trees in Krasnodar territory Bryobia redikorzevi Rekk and Tetranychus crataegi Hirst are the most injurious. The results of four years' studies of the biology of T. crataegi (a common and widespread species in Krasnodar territory) are summarized in this paper. Besides apple tree, this species was observed to injure plum, blackthorn, myrobalan plum, cherry, sweet cherry,* peach, apricot and hawthorn. It has been found also on oak, Persian walnut and on herbaceous weeds growing in orchards. The latter, however, are but facultative hostplants for this species. Fertilized females overwinter under the detached bark on the trunk of trees, in the surface layer of soil, under shed leaves and in other shelters. In the middle of April the mites abandon their shelters and ascend to the crown of the tree where

*Cerasus avium.

at first they feed on the sap of opening buds and later on young leaves. The period of migration from hibernation sites is prolonged til the end of blossoming of apple trees. The propagation of mites goes on all the summer. In the beginning of the summer the mite is rather scarce, rapidly increases in number with the onset of dry hot weather (July, August). First winter females appear at the end of July. They are distinguished by their bright red color. Most of the females migrate to the hibernation sites at the end of September. Eight or nine generations develop during the summer. Under natural conditions, the development of one generation requires from 12 to 19 days. In the laboratory, at the temperature of 22.5–25°C it lasted 12.0-14.5 days, the development of the egg, larva, nymph requiring 4-5, 1-2 and 2.5-3 days respectively. The two nymphal instars, protonymph and deutonymph, require 1-1.5 and 1.5 days respectively. Each molting from one phase to another as well as from protonymph to deutonymph is preceded by a short period of rest, lasting from 0.5 to 1.5 days. In females the interval between the last molt and oviposition varied from one to five days. The average fecundity was 70 eggs per female during the first and 82 during the second year of these studies. The number of eggs deposited per day by one female never exceeds 8. The average longevity of females was 28-30 days. It was found that eggs are deposited by both fertilized and virgin females. All the eggs deposited by unfertilized females develop into males, while only a small proportion of the eggs deposited by fertilized females develop into males. The females which begin to oviposit before hibernation, do not survive through winter, but die with the first frosts. The females, which are to hibernate, do not deposit eggs, though they continue to feed on leaves for some time.

In spite of its abundance in summer and autumn, the pest is quite rare, even hardly detectable, in springtime. This is the result of extremely high mortality during late autumn and winter. Therefore, any method of combatting the pest in its hibernation sites would be practically inefficient and quite inexpedient.

High fecundity and short life cycle result in a high rate of propagation and suggest that T. crataegi is capable of rapid increase in numbers during a relatively short time (mass outbreaks) and of causing severe damage to fruit trees.

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THE BIOLOGY OF LYPEROSIA TITILLANS BEZZI (DIPTERA, MUSCIDAE), AN INTERMEDIATE HOST OF THE NEMATODE PARABRONEMA SKRJABINI

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Lyperosia titillans Bezzi is a widely distributed species in the USSR. It is found in southern Ukraine, in the Crimea, locally in Transcaucasia, throughout the whole of Central Asia and in south Kazakhstan, according to Zimin, 1951. Peus, 1937, states that it occurs in Latvia. Within the USSR, L. titillans has been recorded from the southern European states and from Mongolia.

The literature relating to L. titillans is very scanty. Zimin, 1951, has described the imago and the third instar larva. Little is known about the bionomics of the species except that it is an active bloodsucker, attacking cattle in large numbers and causing them to become restless, lose weight and give a diminished milk yield. The larvae develop in the dung of ruminants.

In 1955, V. M. Ivashkin discovered the epidemiological significance of L. titillans as the intermediate host of the nematode Parabronema skrjabini Rassowsca, 1924, and noted certain characteristic features of its bionomics. His discovery that the imago of L. titillans also feeds on the blood of camels, sheep, goats and many other animals, both domestic and wild, is of considerable importance to animal husbandry, as is the fact that the flies remain on the animals even during rainy weather. Fewer flies are found on the young beasts than on the mature animals. Male flies are usually more numerous than females. The period of maximum activity of the flies occurs during the morning. Eggs are deposited only on fresh manure. The larvae of L. titillans develop well on both cattle and camel dung.

A more detailed study of the biology of L. titillans was undertaken on the scientific expedition organized by the K. I. Skryabin Helminthological Laboratory, Academy of Sciences, USSR, during the period of June to September 1956. The area chosen for research by the expedition was the vicinity of the salt lake Shara-Nur and the Naryn-Gol river which is situated on the southern frontier of Tuvinskii Autonomous Region with Mongolia. Physicogeographically, this region is typical sandy semidesert, intersected by low ranges of treeless hills. The vegetation consists of camel thorn, a species of elm, and rarely of grasses. The climate is severely continental. The locality chosen for investigation was near to the Stalin Cattle Collective Farm for the Tes-Khemskii region.

We wish to record our gratitude and thanks to Professor E. S. Smirnov for his great help to us in our research, to N. A. Tamarin for his valuable assistance as organizer of the expedition and to V. M. Ivashkin for providing the necessary conditions without which experimental work would not have been possible. To V. M. Ivashkin also, we tender our thanks for permitting the publication of facts relating to the preference which L. titillans shows for certain species, ages and sex of animal host.

RESEARCH METHODS

During the expedition we did research both in the laboratory and in the field. The subsequent experimental work was carried out in the faculty of entomology of the Moscow State University.

We made observations using 26 young male camels and 27 female camels, 61 cattle and a flock of sheep comprising 600 animals. Throughout the period of observation, except at night and in the heat of the day, the animals were at pasture.

The following methods were employed for our study of the biology of L. titillans.

Imago. In relation to the various species of animals used in the experiment, we determined the preference of the flies for particular coat colors, for a particular sex and a particular age of host, by counting the numbers of L. titillans on the animals (camels, cattle, sheep and goats) until just after sunset when their activity sharply diminished.

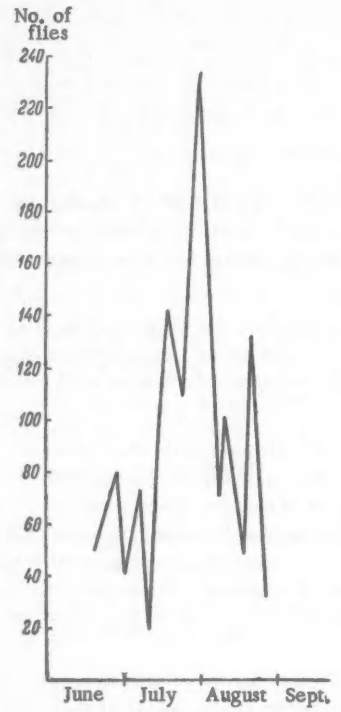


Fig. 1. Abundance of Lyperosia titillans Bezzi in the months June to September 1956 (based on the results of capturing flies on camels over 40-minute periods, twice a week).

In order to determine the exact distribution of flies on the bodies of animals at different times of the day, we made counts of their numbers on the spinal region, base of the horns, belly and head and sciatic concavities of cattle and on the spinal region, belly, legs, head and neck of camels.

The daily rhythm of activity shown by adult insects was established by observing their behavior at different times of the day. During the morning, careful attention was paid to the numerical frequency of flies on the shaded side of the animal's body as compared with that on the sunny side. Simultaneously temperature recordings were taken on the two sides of the animal every five to ten minutes. By this means it was possible to determine any temperature preference displayed by the imago L. titillans.

Twice a week flies were captured from one or other of the old camels; the period of trapping lasted for forty minutes. The results of these trappings are set out in the graph (Fig. 1) and give some idea of the abundance of L. titillans during the months from June to August.

In order to establish the time of oviposition, flies were captured in mechanical fly traps or cages at different times of the day when they came to visit dung.

The perference shown by female L. titillans for the dung of particular species of animals was determined by the following method. In a cage containing the fresh dung of different animals, about 150 flies were placed and left for ten to twelve hours, after which a count was made of the number of eggs layed in the various cages.

Eggs. The length of time taken for the eggs to hatch was determined by leaving two or three hundred flies in a cage containing dung, for an hour, and then examining the dung at hourly intervals, with a view to ascertaining the time when the larvae emerged from the eggs.

Larvae. The aforementioned cages were also used to establish the time taken by the larvae to complete each instar of growth; five to ten samples were taken every twelve hours from the time when the larvae hatched until they pupated. A more accurate assessment of the duration of each instar was obtained in the course of laboratory investigations in Moscow.

Pupae. Three or four days prior to pupation the larvae in dung were transferred to a box of dimensions 40 × 40 × 20 cm., containing fine sand sifted through gauze. After six to ten days, sand was removed from the box in a layer 1 cm deep below the dung, and from a radius of 5-10 and 10-15 cm from the center of the dung pile. The sand thus obtained was sifted once again, and a count was taken of the number of pupae present in it.

ECOLOGY OF IMAGO

L. titillans is a typical "pasture" species, adapted to steppe and semidesert country. It is almost completely ectoparasitic and feeds on the blood of camels, cattle, horses, sheep and goats, only quitting the host animals at the time of oviposition.

Preference Shown for Particular Species, Color, Sex and Age of Host Animal

Counts of flies were made on different species of host and our results agreed with those of V. M. Ivashkin in showing that L. titillans has a definite preference for camels. Several thousand flies were observed and counted as can be seen from Table 1. Cattle took place after camels in the order of preference. According to our observations the number of flies on certain cows reached a thousand. On sheep and goats the number of flies never exceeded 150.

According to Zimin, 1951, L. titillans shows a distinct preference for dark colored animals. However, the results of our own observations are not as positive in this respect (Table 1). Furthermore, the number of flies on cattle, varies very considerably from animal to animal, irrespective of color. We conclude that age is a more important factor than color in determining the preference of flies for particular animals, for the number of flies on five-and six-year-old cattle is always several times greater than that on two-and three-year olds.

TABLE 1

Preference Displayed by Lyperosia titillans Bezzi for Host Animals of a Particular Species and Color (counts taken until sundown)

Host animals	Color	Date and weather			Mean of three	
		11 Aug. rain	13 Aug. rain	16 Aug. rain	absolute value	% of total figure
Camels	Brown (castrated ♂)	2000	1000	300	1100	38.5
	Brown (old ♀)	140	400	200	247	8.9
	Brown (old ♀)	300	500	800	533	18.6
	White (♀)	130	100	30	83	3.0
	White (♀)	100	35	20	52	1.8
	Brown (♀)	60	80	100	80	2.8
	White (♀)	50	80	60	63	2.2
	Brown (♂)	23	16	32	24	0.8
	White (♀)	10	27	12	16	0.5
	Brown (♀)	11	4	15	10	0.3
	Total for camels	. . . .	. . .	. . .	2211	76.5
Cattle	Reddish (bull)	200	150	300	216	7.6
	Black (♀ old)	50	80	150	93	3.2
	Brown (♀)	80	70	80	76	2.6
	Straw-colored (♀)	24	100	80	68	2.4
	Black (♀)	33	52	90	58	2.0
	Black (♀)	50	46	60	52	1.8
	Reddish (♀)	60	36	33	43	1.5
	White (♀)	20	16	70	35	1.2
	Black (♀)	17	8	32	19	0.6
	Reddish (♀)	9	21	20	17	0.6
	Total for cattle	. . . .	. . .	. . .	677	23.5
	Totals	. . . .	. . .	. . .	2888	100

L. titillans always occurs in greater numbers on male hosts than on females, and on old animals than on young ones. It is quite likely, according to Ivashkin, 1955, that the preference shown by this species is for strong-smelling and the most freely perspiring beasts.

The number of flies varies considerably from one part of the season to another, but the numerical ratio between those on one species of animal and another is always constant.

Daily Rhythm of Activity, and Distribution Over Body of Host.

It would appear that the host animal is the only habitat for L. titillans as the number of flies on the host hardly changes at all during the course of the day; moreover, sweep nets dragged through the scanty herbage around standing cattle or camels never yield any captures of flies.

The flies are markedly active in sunshine and at high temperatures, but in the hottest part of the day (from 11 A.M. to 5 P.M.) when the temperature attains 30-40°, they are less active and for the most part just sit around on the shaded parts of the animal's body. On camels, they burrow into the longer hair of the neck, hump and knees. L. titillans returns and settles down again almost immediately after being scared away from the host.

Between 5 and 6 P.M. the flies regain their activity and their period of maximum activity is reached in the last two hours before sunset; during this time they keep on the unshaded side of the animal, make frequent flights and sit around cleaning their wings and legs. It is interesting to note that other species of flies, which are extremely active around midday, are almost entirely absent at this time.

For half an hour before sunset, when the temperature has fallen below 25°, the flies cease to be active and become concentrated on the warmer parts of the body. On cattle, the majority of the flies remain around the base of the horns, along the backbone and sometimes in the sciatic concavities, whereas on camels they assemble in small groups (of from 10 to 30 individuals) on the wool, or burrow deeply into it.

The early morning distribution of flies on the host, before sunrise, is the same as that in the late evening. Therefore, under natural conditions, the flies are kept warm by the heat of the host's body during the night and do not pass into a cold rigor.

In fine weather, the flies commence their activity ten to fifteen minutes after sunrise and begin to move about on the sunny side of the animal; at this time there are no other species of flies to be found on camels.

Thirty to forty minutes after sunrise when the temperature of the air attains 26-30°, the morning peak (and also the daily peak) activity ensues; the flies are constantly flying from place to place, copulating, sucking blood, or cleaning their legs and wings. When the temperature on the unshaded side of the host attains 35-37°, the number of flies drops sharply, as many of them fly over to the shaded side or burrow into the hair.

From these observations it may be concluded that the optimum temperature for the imago of L. titillans lies between 25 and 35°.

Behavior in Relation to Meteorological Conditions

In rainy weather the flies are less active and tend to be localized on the drier parts of the host's body. Usually they assemble in small groups under the belly and below the humps, hiding away in those parts of the hair that have not already been shed. We have noticed that the flies prefer the side of the body away from the wind.

Seasonal Sequence of Abundance

L. titillans is most active in summer. In the summer of 1956, we observed three peak periods of abundance: during the second half of June, at the end of July and in the middle of August (Fig. 1). Usually each peak coincided with a period of fine weather. In September there were few flies about.

From a study of the abundance of this species and the time required for a single generation (23 days under optimum conditions) it is possible to deduce that L. titillans had three or four broods in the summer of 1956.

The variation in numbers of flies depends on the weather. Cold and rainy weather extending over several days causes the number of flies to fall to a minimum (on cattle we caught only a few flies at such a time); this drop in numbers over the first two or three days is brought about mainly as a result of the reduction in number of males. A day or two after the return of fine weather the numbers of flies increase rapidly, with the males sometimes becoming one and a half times as numerous as the females; this increase continues until, after seven or eight days, a peak period of abundance is reached, with the males still predominating.

Feeding

Both male and female L. titillans are obligate bloodsuckers of animals and sometimes of human beings, according to Shtakel'berg, 1956. They choose a place where the skin in thinnest and the hair is shortest when they bite their victims. On camels it is most usual to see the flies feeding on the inguinal region. The act of bloodsucking lasts from three to eleven minutes. At this time the flies attach themselves so forcibly to the skin of the animal that is is very difficult to remove them.

As almost permanent ectoparasites, the flies never experience a lack of food and therefore they feed often (every 3 or 4 hours) but on small quantities. This is in line with such anatomical features as the almost complete disappearance of the crop, the cylindrical form of the stomach as compared with the flask-shaped stomach of mosquitoes, which is made to receive a further meal of blood before the previous meal has been fully digested according to Kuzina, 1950. The period of maximum feeding activity corresponds with the time of greatest general activity during each day. Ten to thirty flies have been observed feeding at one time at 6 or 7 A.M. whereas in the hottest part of the day only two or three flies may be seen sucking blood.

TABLE 2

Preference Shown for Manure of Different Animals by Pupating Female L. titillans

Date in 1956	Host animals	Approximate no. of flies trapped on animals	No. of eggs laid in manure				
			of camels		of cattles	of goats	of horses
			liquid	in little lumps			
27 VII	Camels	150	7	—	2	33	—
10 VIII			0	0	7	—	0
16 VIII			0	3	7	—	—
20 VIII			68	—	41	—	—
27 VII	Cattles	150	32	—	104	17	—
22 VIII			12	—	81	—	0

Note: Dashes mean that the manure of a given species was not used in the particular experiment. A nought means that no eggs were layed in the manure.

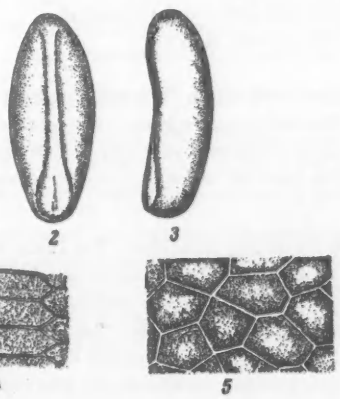
Several thousands of flies may be observed on certain animals during the period of mass flight in L. titillans. The reaction of the animals to such an abundance of flies varies with the species; cattle become very restless, whereas camels appear to be almost insensitive to bites, as even when the flies are most active they remain quite calm.

The question of any subsidiary diet other than blood for L. titillans has not been resolved. No flies of this species were caught in mechanical fly traps when kvass, a fermented liquor, was used as bait. However, flies which had been placed in cages with manure, sucked up some of the manure through their probosces.

Oviposition

L. titillans is an oviparous species. Seven to twenty eggs are laid in each oviposition, and up to five or six ovipositions may occur. Under the conditions prevailing in southern Tuva, eggs are laid on either cow dung or camel dung. Our experiments show that the female flies exhibit a preference for laying their eggs in the manure of the animal from which they were captured (see Table 2). The nomadic animal husbandry which is characteristic of Tuva means that there is always a number of cattle around the yurts (tents) and therefore the adult flies which feed on sheep and goats may still develop as larvae in cow dung.

As the flies are most active in the morning, we presume that oviposition takes place most frequently at this time. Females may be caught on dung in considerable numbers until 8 A.M., but after that time their capture occurs at infrequent intervals. The illumination of the dung by the sun is a significant factor in relation to oviposition. Our traps shielded the bait to some extent and therefore the females rarely flew into them. The best results were obtained when the flies were caught in nets. Female flies would only lay their eggs



Figs. 2-5. Egg structure in Lyperosia titillans Bezzi; 2) egg in dorsal view; 3) egg in lateral view; 4 and 5) portion of chorion, greatly magnified.

on fresh manure. We were never able to capture flies on manure which had lain on the ground for more than thirty minutes.

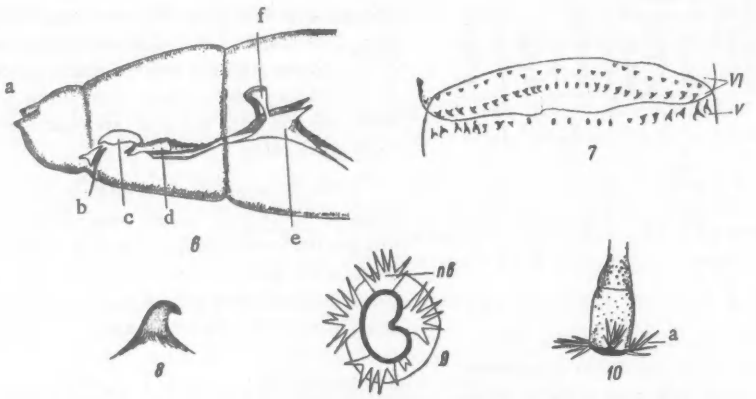
THE EGG

The egg of L. titillans (see Figs. 2-5) is elongate, oval, slightly curved; the top is more strongly curved than the base. There are two dorsal grooves present, the distance between them being one third of the width of the egg; the groves extend from the anterior end toward the posterior end and join immediately in front of the latter. The freshly deposited egg is white but becomes a brownish orange color after several hours. On the chorion are small, regular hexagonal or irregular four-sided cells forming a definite pattern. The length of the egg is 1.0-1.2 mm and its width is 0.4-0.5 mm.

In the conditions prevailing in south Tuva the eggs hatch after 22 to 36 hours.

THE LARVAE

First instar larva (Figs. 6-10). This larva is metapneustic. The posterior spiracles have reniform apertures, surrounded by four groups of palmate hairs.



Figs. 6-10. Structural details of first instar larva of Lyperosia titillans Bezzi. 6) Buccopharyngeal apparatus: a – antennae, b – labial sclerite, c – dorsal sclerite, d – hypostomal sclerite, e – pharyngeal sclerite, f – dorsal crosspiece; 7) ventral armature of abdominal segments V and VI; 8) individual spinule of abdominal segment V; 9) posterior spiracle: a – palmate hair; 10) same in side view.

The body is elongate, cylindrical and noticeably tapering at the anterior end. The head segment is bipartite; the antennae are well developed. Thoracic segments and first abdominal segment lack spinules; abdominal segments (II-VII) having a cylindrical thickening on their anterior margins ventrally, which carries three transverse rows of small spinules, the latter increasing in number from the second to seventh segment; the second row of spinules have their points directed backwards.

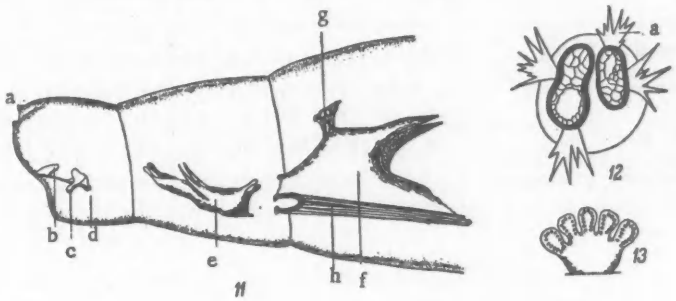
The buccopharyngeal apparatus is of the form characteristic of the family Muscidae. The labial sclerites are triangular. Paired buccal crotchets (jaws) are absent, their place being taken by a median dorsal sclerite which is the homolog of the labrum and consists of an unpaired elongate lamina with parallel upper and lower edges, bearing on its ventral surface a curved toothlet and further small toothlets on its anterior margin. The hypostomal sclerite is represented by two laminae, united above by a wide crosspiece, having a pointed anterior margin and elongate, slender, posterior processes which join on the anterior process of the pharyngeal sclerite.

The pharyngeal sclerite is in the form of two triangular plates each with an elongate process at its corners; the two plates are joined dorsally by a thin, high bridge; the posterodorsal processes are equal in length and only half the length of the ventral processes.

Second instar larva (Figs. 11-13). This larva is amphipneustic. The anterior spiracles possess five mammiform processes. The posterior spiracles are placed in such a way that their distance apart is equal to two and a half times their diameter; each spiracle has two bean-shaped apertures, of which the inner is smaller than the outer and the spiracle possesses four groups of palmate hairs.

Body without spinules on thoracic or abdominal segments. Thoracic segments (II-VII) with cylindrical, transversely striated thickenings, ventrally situated on their anterior margins.

The buccopharynegeal apparatus is very different from that of the first instar larva, because of the presence of new sclerites and the extension of the original ones. Below the mouth are the buccal crotchets, strongly sclerotinized structures, which are joined to the triangular labial sclerites by narrow ties. To the outside of the buccal crotchets are found T-shaped sclerites, the ventral processes of which form a pair of large teeth lying one on either side of the mouth. A wide ventral crosspiece joins the paired hypostomal sclerites, at the front and rear of which are dorsal processes with clavate apices; in addition to these dorsal processes a pair of oval-shaped processes point anteriorly from the middle of the hypostomal sclerites. The pharyngeal sclerites are trapeziform and have wide, somewhat truncate anteroventral processes and more slender, pointed posterodorsal ones. The



Figs. 11-13. Detailed structure of second instar larva, Lyperosia titillans Bezzi. 11) Buccopharyngeal apparatus: a - antennae, b - buccal crotchets, c - toothed sclerite, d - labial sclerite, e - hypostomal sclerite, f - pharyngeal sclerite, g - dorsal sclerite, h - pharyngeal membrane; 12 - posterior spiracle: a - palmate hair; 13) anterior spiracle.

pharyngeal crosspiece is small, expanded dorsally and possesses a large aperture. The anteroventral processes are connected by a distinct crosspiece, which is extended posteriorly in the form of a transparent pharyngeal membrane. The oesophagus almost reaches the ventral process of the pharyngeal sclerite.

Third instar larva. This larva has already been described in detail by Zimin, 1951.

Ecology. The larva of L. titillans is coprophagous and develops in cow or camel dung. So far, we have been unable to capture female L. titillans on the dung of any other species, although V. M. Ivashkin, under somewhat artificial conditions, successfully reared the larvae on horse manure.

The young larvae remain in the superficial layer of intestinal mucus which covers the manure at first, but as this layer dessicates they migrate downwards until finally they come to lie almost on the surface of the soil. When larvae are reared in cages an analogous vertical migration is found to take place, but the addition of fresh manure to the original pile attracts the larvae and they become concentrated in it, irrespective of whether it is placed above or below the original pile.

The larval stage usually lasts from ten to sixteen days but dull, cloudy or rainy weather may prolong it to a month.

The duration of the various instars under laboratory conditions are as follows: first instar 1-1.5 days, second instar 2.5-3.0 days and the third instar 6-10 days.

A rapid change in temperature under natural conditions may speed up the development.

PUPA

Pupation usually takes place in the soil at a depth of 1-3 cm (Table 3). Evidently, at this depth conditions are most favorable, for we found that 80% of the pupae occurred within the first three centimeters of the soil. The major part of the (37%) were found at a depth of 1 cm. At depths of 3-5 cm the number of pupae fell sharply and only single examples occurred in the range 6-7 cm. No pupae were found below 7 cm. Migration of the larvae in a lateral direction was very slight: 90.5% of the larvae pupated immediately underneath the pile of dung at various depths, whereas only 9.5% migrated more than 5 cm from the edge of the pile; outside that limit no pupae were found.

TABLE 3

The Distribution of Lyperosia titillans Pupae in the Soil (mean of 3 replicates in absolute numbers [I] and as a percentage of total [II])

	Horizontal distribution of pupae	Vertical distribution of pupae									
		in dung	1 cm	2 cm	3 cm	4 cm	5 cm	6 cm	7 cm	8-10 cm	Total
I	Under pile of dung	1.0	22.7	18.7	9.0	0.7	0.7	2.7	1.0	0.0	56.5
	Within a radius of 5 cm from edge of dung	—	1.0	1.0	0.0	3.0	0.7	0.3	0.0	0.0	6.0
	Total	1.0	23.7	19.7	9.0	3.7	1.4	3.0	1.0	0.0	62.5
II	Under pile of dung	1.6	36.2	30.2	14.4	1.1	1.1	4.3	1.6	0.0	90.5
	Within a radius of 5 cm from edge of dung	—	1.6	1.6	0.0	4.7	1.1	0.5	0.0	0.0	9.5
	Total	1.6	37.8	31.8	14.4	5.8	2.2	4.8	1.6	0.0	100

The puparium is usually covered with fine grains of sand, which closely adhere to its surface. When the sand is cleaned off, the puparium (Fig. 14) is seen to be a light brown color; it is elongate in form with a narrower anterior end. The segmentation is clearly marked. A pair of anterior spiracles open on to the head segment and these are protuberant and bear fine mammiform projections.

Fig. 14. Puparium of Lyperosia titillans Bezzi.

The line marking the exit site of the imago on the puparium, is a dark, slightly raised edging, extending from the side of the thoracic segments I and II and bending toward the center of segment III. All the segments have slender, transverse striations. The posterior spiracles are dark colored and somewhat raised.

The pupal stage lasts 9-12 days but may be more prolonged under unfavorable conditions.

ENEMIES

The enemies of the adult L. titillans are parasitic wasps of the genus Oxybelus. In July and August, these wasps may be frequently seen sitting motionless on the wool of camels or stalking their prey. It was possible to capture the wasps carrying parasitized flies; L. titillans (2 cases), Musca tempestiva Fiin. (1 case), M. amica Zim. (2 cases).

On the body of L. titillans may be found parasitic mites belonging to the families Tarsonemidae, Ascaidae, Parasitidae and Trombiculidae.

The larvae of L. titillans are destroyed by ground beetles (Carabidae), histerid and staphilinid beetles. In the field, we never found larvae in manure overrun by ants.

L. TITILLANS AS THE INTERMEDIATE HOST OF PARABONEMA

L. titillans is the intermediate host for the worm, Parabronema skrjabini Rass. This large nematode, up to 45 mm long is bright red in color and inhabits the abomasum of domestic and wild ruminants.

The elucidation of the life cycle of P. skrjabini was accomplished by V. M. Ivashkin in 1955. According to him, the transmaission of the helminth takes place in the following manner. The female P. skrjabini, localized in the abomasum, lays eggs which pass out to the exterior in the feces. Larval L. titillans developing in the feces, swallow the eggs of Parabronema. The subsequent development of the nematode takes place in the larvae, pupae and adult L. titillans. First stage larvae of the helminth may be found in the fly larvae, second stage larvae in the pupae and third stage larvae are transmitted to the vertebrate hosts by the imago L. titillans.

The number of Parabronema in the abomasum may attain several thousands, whereupon the animals are very much emaciated. The parasites may live for fifteen to nineteen months in the definitive host.

SUMMARY

1. Lyperosia titillans Bezzi is a typical "pasture" species occurring in the steppe and semidesert zone and widespread in the southern regions of the USSR (both European and Asiatic), in the south of Central and Western Europe and in Mongolia. The present investigation has been carried out in the southern Tuva, near the frontier of Mongolia.

2. The adults are obligate bloodsuckers, feeding on camels, cattle, horses, sheep and goats. No preference for any particular hair color of the host was observed. Aged animals are obviously preferred.

3. The adult L. titillans is an almost constant ectoparasite. Ectoparasitic mode of life is interrupted only for a short time, when females leave the host for oviposition. Easy and constant access to food has resulted in the progressive evolution of the alimentary system of the adult. The crop is almost entirely reduced. Being compared with L. irritans L., L. titillans Bezzi can serve as an example of progressing parasitism at the adult phase within the tribe Stomoxydini.

4. The maximum diurnal activity is observed at the morning and evening hours.

5. Three peaks in the curve of the number fluctuations have been observed during the summer of 1956 in southern Tuva, viz.,in the second half of June, the end of July and the middle of August. Each of these peaks coincided with fine weather.

6. Females deposit 7-20 eggs into the dung of cattle and camels, where the larval development takes place. The larvae pupate in the soil at the depth of 1-3 cm. In the southern Tuva the entire life cycle was observed to require 23 days (under optimum conditions).

7. On the basis of the life-cycle duration and fluctuations during the summer it can be assumed that there were three or four generations of L. titillans in 1956 in the southern Tuva.

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A NEW SPECIES OF APHIS (HOMOPTERA, APHIDIDAE) ON COTONEASTER

G. Kh. Shaposhnikov

Until recently no aphid species specific to cotoneaster were known. The only species recorded from this plant were oligophagous forms encountered on all or nearly all Palaearctic Pomoidea, such as Rhopalosiphum insertum Walk. and Aphis pomi Deg., as well as Eriosoma lanigerum Hausm. (Börner, 1952).

Recently a specialized species – Dysaphis microsiphon Nevs. – was found on cotoneaster. Judging by the collected material from which Nevskii (1951) described the new species Brachycaudus subspinosus Nevs., this is the spring wingless agamic form of Dysaphis microsiphon Nevs., collected in 1937 not on Rhamnus, as the label indicates, but in all probability on cotoneaster. In 1948, this species was collected by M. N. Narzikulov on Cotoneaster insignis Pojark. and determined by the present author, although Narzikulov (1949 : 59) cited only the local name for cotoneaster ["Yezabura microsiphon Mordv. (!) on irga gissarskoi"], after which the fundatrices and migrantes were described (Narzikulov, 1955a, and again in 1955b). The author carried out a successful transfer of aphids from Cotoneaster nummularia F. A. M. onto Metha silvestris L. on May 9, 1953 in Karakala in southwest Turkmenia (Shaposhnikov, 1955). The transplants reproduced until June 2, after which the experiment was terminated. In the Caucasus this species was found by the author on Contoneaster saxatilis Pojark. and Cotoneaster sp.

A description of yet another species of aphis specific to cotoneaster is presented below.

Dysaphis (Anuromyzus, subgen. nov.) cotoneasteris, sp. nov.

Fundatrix (May 28, 1 specimen). Interrupted sclerotized bands on the pronotum and abdominal tergites VII-VIII. Marginal tubercles present on the metathorax as well as on the prothorax and abdominal tergites I-V. Spiracles of abdominal segments I and II approximated but still far apart. Antennal prominences low, strongly divergent. Antennae 5-segmented. Otherwise similar to the wingless agamic female.

Body 2.50 × 2.00. Antennae 0.95 : III 2.18 × 0.37, IV 0.15, V. 0.10 + > 0.10 (apex of terminal spine truncated). Cornicles 0.28 × 0.07 (before the base), × 0.04 (before the apex). Cauda 0.11 (approximately) × 0.12 (before the base).

Wingless agamic female (May 28, 34 specimens, Figs 1, 2). Broadly oval-ellipsoid, with strongly convex dorsum; black above except for the brown intervals between the sclerites, very shiny, brown below. Cuticle alveolar; on the unsclerotized portions of the upper surface of the body the alveoli are formed by high rugose lamellae, reminiscent of the cuticle of Anuraphis Guerc., and between the alveoli there are frequently some ornate lamellae; on the sclerotized portions, the alveoli are formed or only suggested by series of indistinct rounded spinules, for the most part merged together; on the lower surface of the body, the alveoli are formed by small spinules and are often transversely elongated; head cuticle with scattered round spinules; on tergites VII-VIII the alveoli are formed by thick spinules which do not merge. Transverse bands on the pro- and mesonota and abdominal tergite VIII, and a continuous broad section from the metanotum to abdominal tergite VII, sclerotized, with the exception of small areas about the cornicles; in the majority of specimens the continuous sclerotized area on the metanotum and abdominal segments I-III is interrupted medially by a fined broken stripe of unsclerotized cuticle; rarely the continuous area is interrupted by irregularly shaped spots which are partially merged together; sometimes the continuous area merges with the small sclerites on which the marginal

tubercles are situated. Marginal tubercles small, weakly convex, present on the prothorax and abdominal tergites I-V, though sometimes absent on tergite V on one or both sides. Setae on the dorsal surface of the body, on the antennae, and sometimes a few on the legs, short, blunt or even slightly broadened at the apex; the longest seta on the third antennal segment equal to 2-3 times the width of the segment, the longest on the third abdominal segment 3-4 times the width of the antennal segment; setae on the lower body surface, on the frons, and in part on antennal segments I-II and the legs, normal, long, and acute at the apex. Spiracles reniform, situated posterior to the lamellae, much more ventral than the marginal tubercles; spiracles of abdominal segments I and II approximated such that their sclerites often more or less merge together; spiracle on the first abdominal segment somewhat dorsally displaced. Frons grooved, with a median prominence; antennal prominences high, divergent, but sometimes almost parallel, their interior apical angles slightly projecting, reminiscent of the antennal prominences of Myzus Pass. Antennae 6-segmented, rather stout, covered with scales, which become more numerous from the base to the apex of the antenna; permanent sensoria with a crown of cilia, sixth segment with 6 accessory sensoria. Eyes normal. Beak reaching to the median coxae, its apical segment narrowly conical with 3 pairs of apical setae and 1-3 unpaired basal setae. Legs rather short and stout; spines on tarsal segment I: 3 - 3 - 2. Cornicles dark, cylindrical, narrowing from the middle toward the apex and sometimes at the base, covered with small, sparse scales made of spinules which are partly fused; rims at the apices of the cornicles well developed. Cauda helmet-shaped and apically acute, covered with small acute spinules, with 7, or more rarely 6, curved setae.

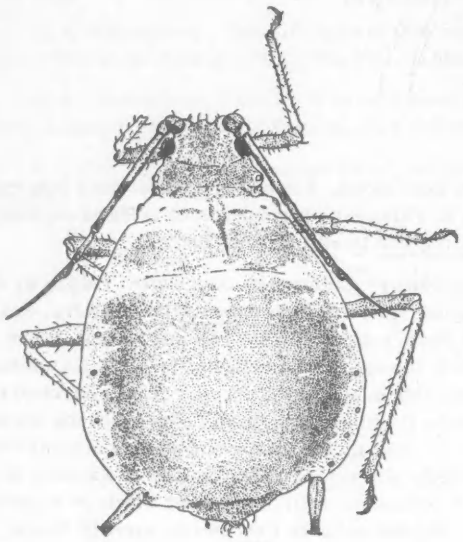

Fig. 1. Wingless agamic female Dysaphis cotoneasteris Shap., sp. n.

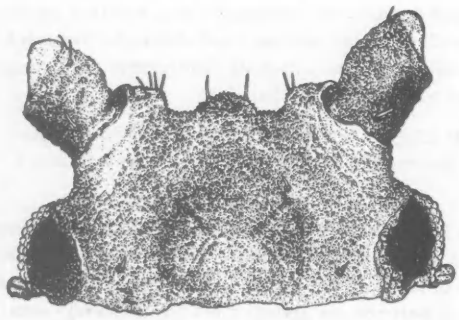

Fig. 2. Head of wingless agamic female Dysaphis cotoneasteris Shap., sp. n.

Body 2.20 x 1.25. Antennae 1.38 : III 0.40 x 0.04, IV 0.23, V 0.18, VI 0.08 + 0.37. Cornicles 0.28 x 0.08 (at the basal half), x 0.05 (before the apex). Or: body 2.62 x 1.62. Antennae 1.76 : III 0.54 x 0.046, IV 0.29, V 0.19, VI 0.10 + 0.48. Cornicles 0.35 x 0.08 (at the basal half), x 0.05 (before the apex). Cauda 0.13 x 0.11 (at the basal half).

Larvae brown, shiny. First instar (May 28) with 5-segmented antennae, marginal setae from the pronotum to abdominal tergite VII, supramarginal from the mesonotum to IV, median from the pronotum to VIII.

Winged agamic female (May 28, 4 specimens). Broadly oval. Cuticular alveoli much more indistinct than in the wingless ones. Thorax, transverse bands on abdominal tergites I (narrow) and II-VIII, large marginal areas on II-IV, and a continuous area, not reaching the marginal ones, on abdominal tergites III-VII, sclerotized. Setae less obtuse apically than those of the wingless form. Marginal tubercles more strongly convex than those of wingless form. Antennal segment III with 63-80 secondary sensoria, segment IV with 18-23, segment V with 3-6; sensoria variable in size, some very large, rounded or irregular in shape, partly transverse, often strongly convex, with a fairly broad marginal concave portion. Wings normal, M branching twice. Cornicles cylindrical, slightly narrowing at the apical fourth. Otherwise similar to the wingless form.

Body 2.30 × 1.22. Antennae 2.20: III 0.72 × 0.05, IV 0.40, V 0.25, VI 0.10 + 0.55. Forewing 3.90. Cornicles 0.37 × 0.06 (at the basal half), × 0.04 (before the apex). Cauda 0.13 × 0.12 (before the base).

Winged sexuparae (October 17, 26 specimens). Less sclerotized than the spring agamic winged females: no bands on tergite I, as a rule; on tergite II it is narrow and usually not merged with the continuous area, from which the band on tergite VII is sometimes also separated. Setae for the most part apically acute, with only a few slightly obtuse. Marginal tubercles present on abdominal segments I-V as a rule. Antennal segment III with 73-99 secondary sensoria, segment IV with 28-42, V with 5-12. Otherwise similar to the spring winged form.

Body 1.95 × 1.00. Antennae 1.93 : III 0.62 × 0.05, IV 0.40, V 0.26, VI 0.09 + 0.50. Forewing 3.45. Cornicles 0.27 × 0.05 (at the base), × 0.04 (before the apex). Cauda 0.12 × 0.11 (before the base).

Wingless sexuparae (of winged type) (October 17, 6 specimens). Oval. Sclerotized bands on the pro- and mesonota either as in winged or wingless forms; band on metanotum fused with or slightly separated from continuous area; marginal areas large but somewhat smaller than those of winged forms, largely merged with the continuous area to a certain degree. Tergites of pro- and mesothorax somewhat intermediate in form between those of the winged and wingless forms. Three ocelli on the head. Antennae seldom with secondary sensoria: 11-12 on segment III and 5-7 on IV. Otherwise similar to spring wingless form.

Body 2.08 × 1.26. Antennae 1.45 : III 0.45 × 0.04, IV 0.23, V 0.17, VI 0.09 + 0.38. Cornicles 0.29 × 0.06 (before the base), × 0.04 (before the apex). Cauda 0.12 × 0.12 (before the base).

Normal female (October 17, 6 specimens). Oval, hindend almost not elongated. Bands on the thoracic tergites, abdominal tergites I-III and VIII, sclerotized, the bands short on the first abdominal tergites, often in the form of interrupted spots or completely absent. Hindtibiae thickened, 1.5-1.7 times thicker than the median tibiae, covered with numerous rounded pseudosensoria. Otherwise similar to the wingless form.

Body 2.00 × 1.23. Antennae 1.04 : III 0.26 × 0.036, IV 0.17, V 0.13, VI 0.08 + 0.28. Cornicles 0.22 × 0.06 (before the base), × 0.04 (before the apex). Cauda (approximately) 0.11 × 0.10.

Winged male (October 17, 19 specimens). Narrowly ellipsoid-oval. Thorax, bands on abdominal tergites I-VIII, and marginal areas on tergites I-VII, sclerotized; bands are usually weak and interrupted, on tergite I barely, on II weakly, expressed, rarely stronger, forming a large area on tergites III-VII or IV-VI, although not fused in this case; on tergites VI and VII the bands occasionally fuse with the marginal areas to a certain degree. Setae acute. Antennal segment III with 76-97, but in one case with 43, secondary sensoria, segment IV with 26-32, but in one case 16, and V with 7-11. Cornicles evenly cylindrical. Otherwise like the winged agamic female.

Body 2.00 × 0.80. Antennae 2.00 : III 0.57 × 0.05, IV 0.35, V 0.25, VI 0.09 + 0.61. Forewing 3.25. Cornicles 0.24 × 0.041 (before the base), × 0.037 (before the apex). Cauda 0.11 × 0.10 (before the base).

The aphids were collected on October 17, 1953, in the Caucasian mountains in the Borzhomi region on two species of plants at the same time: Cotoneaster saxatilis Pojark. and Cotoneaster sp. At the same place and on the same plants an additional collection was made on May 28, 1955 at my request by the Tiflis aphidologist A. A. Dzhibladze, to whom I extend may sincere thanks. The aphid colonies were located on the underside of the curled leaves, often both in spring and autumn, together with Dysaphis microsiphon Nevs. Dzhibladze observed a reddening of the leaves, though it isn't clear by which of these two species this is caused. He also collected D. cotoneasteris, sp. n., on C. recemiflora (Dsf.) Koch in Tiflis.

The presence of wingless autumn forms of the winged type, in all probability sexuparae (androparae), suggests that this species is autoecious.

Comparative notes. This species shows certain characteristics which bring it close to representatives of the polymorphic genus Dysaphis CB.: the helmet-shaped cauda with few setae, the alveolar cuticle with rudimentary ornate lamellae inside the alveoli, the presence of different setae – primarily acute in the winged forms and primarily blunt in the wingless ones. However, in its structure the sculpturing of the cuticle occupies an intermediate position between that of Dysaphis CB., on the one hand, and Zinia Shap. and Anuraphis Guerc. on the other.

The described species is close to Zinia Shap. with regard to the extensive sclerotized portion of the cuticle on the dorsum of the apterous forms and the short, blunt setae. As for the frons, with its rather high, almost parallel and slightly projecting antennal prominences, perhaps it takes a step in the direction Myzea. A further approach toward Myzea may also be seen in the rugose sclerites which form the alveoli of the cuticle.

The described species may conditionally be placed in the genus Dysaphis CB.; the new subgenus occupies an intermediate position between Dysaphis CB. and Zinia Shap.

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NOTES ON THE COCCOIDEA OF CHINA

V.* A NEW GENUS AND SPECIES OF SCALE INSECTS (HOMOPTERA, COCCOIDEA, PHOENICOCOCCIDAE) FROM THE PROVINCE OF SZUCH'UAN. (SCIENTIFIC RESULTS OF THE SINO-SOVIET EXPEDITIONS OF 1955-1957 IN SOUTHWEST CHINA)

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The present paper is devoted to a descrpition of a new genus and species of scale insects of the family Phoenicococcidae – Protancepaspis bidentata Borchsenius et Bustshik, gen. et sp. n., collected by O. P'ing-yung, member of the Entomological Institute of the Academy of Sciences of China, and T. N. Bushchik, member of the Zoological Institute of the Academy of Sciences of the USSR, in the Province of Szuch'uan at the beginning of the summer of 1955 during the joint faunistic expeditions.

The type of the new species is preserved in the collection of the Entomological Institute of the Academy of Sciences of China and the paratypes in the collection of the Zoological Institute of the Academy of Sciences of the USSR.

Protancepaspis Borchsenius et Bustshik, gen. n.

Adult female. Broadly pear-shaped with an elongated and acute abdomen, up to 1.2 mm in length. Outer body covering weakly sclerotized except for a small portion of the dorsal pygidial surface. All body segments fused, no clear division between the pygidium and the remaining abdominal segments. Antennae represented by unsegmented tubercles with a few setae. A group of discoidal pores in front of the anterior spiracles; a group of tubular ducts behind the posterior spiracles. Marginal tubular ducts with two rims situated along the margin of the pygidium. Small tubular ducts developed on the ventral surface of the pygidium. Anal aperture situated anterior to the vaginal opening, at the base of the pygidium. Perivulvar pores present.

1st instar larva. Newly hatched larva oval, about 0.2 mm long. Antennae 5-segmented. Mouthparts and legs well developed, tibiae much shorter than tarsi. A row of tubular ducts situated along the margin of the thorax. Short setae situated on both surfaces of the body; bristles on abdominal apex developed.

Males not found.

Type of genus – Protancepaspis bidentata Borchsenius et Bustshik, sp. n., China, Szuch'uan Province.

Closely related to the genus Ancepaspis Ferris; the adult female may be distinguished by the developed marginal tubular and perivulvar ducts of the pygidium, the presence of discoidal pores before the anterior spiracles and tubular ducts behind the posterior spiracles, and also by the location of the anal aperture, which is situated at the base of the pygidium anterior to the vaginal opening; the first instar larva is separated by the

*First contribution: Acta Entomologica Sinica, 1956, III : 101-106; second: Éntomologicheskoe Obozrenie, 1958, XXXVII : 156-173 [see English Translation]; third: Acta Entomologica Sinica, 1958, VIII : 168-178; fourth: Acta Entomologica Sinica [in press].

5-segmented antennae and the developed tubular ducts not only on the abdominal segments but also on the thoracic.

Protancepaspis bidentata Borchsenius et Bustschik, sp. n.

Adult female. Broadly pear-shaped with a strongly elongated and acute pygidium (Fig. 1), 1.0-1.2 mm long. Outer body covering behind the mouthparts shagreened on a narrow longitudinal band along the midline of the body almost to the middle of the abdomen. Antennae with one long and 2-3 very short setae. 5-7 discoidal pores before the anterior spiracles; 5-7 tubular ducts behind the posterior spiracles. Ventral surface

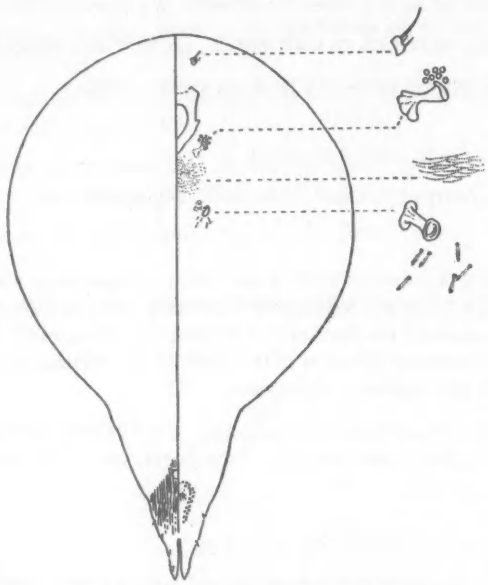

Fig. 1. Protancepaspis bidentata Borchs. et Bustsh., sp. n. adult female.

along the middle of the body with some small tubular ducts. Pygidium narrow, the apex cleft (Fig. 2); each lobe elongated, apically dentate along the outer edge; 4 pairs of marginal pores; small tubular pores present on the submarginal zone of the ventral pygidial surface; anal aperture situated on the anterior portion of the pygidium, before the vaginal opening; perivulvar pores grouped into a horseshoe-shaped figure, the number of pores varying from 65 to 80. Body setae short.

Female enclosed in a light brown, shiny, broadly pear-shaped puparium; puparium covered with a loose white scale; larval exuvia whitish, fine, situated at the head end of the scale, often lost.

Male not found.

1st instar larva (Fig. 3). Elongate-oval, 0.2-0.3 mm long. Antennae 5-segmented, all segments except the 3rd setose. A row of 9 tubular ducts along the margins of the thorax and abdomen on either side of the body. Dorsal body surface with 2 medial rows of short setae and a marginal row of longer setae on either side of the body; a double submarginal row of setae on the ventral abdominal surface. Pygidium with 2 pairs of small, acute, lobular formations. Anal aperture circular, located at the apex of the abdomen on the dorsal body surface.

Province of Szuch'uan Omeishan Mountains, southwest Ch'engtu, 620 m above sea level. On the young twigs and leaves of Rubus Parkeri Hance (Rosaceae), June 20, 1955 (including the holotype ♀), O.P'ing-yung and T. Bushchik.

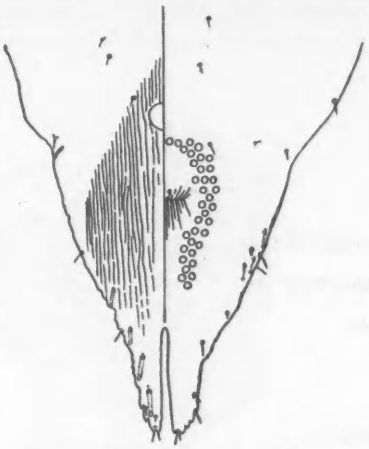

Fig. 2. Protancepaspis bidentata Borchs. et Bustsh., sp. n., female pygidium.

The females are distributed singly or in small groups; on the leaves the females are usually found along the veins on the underside. The head end of the puparium is closely applied to the plant tissue, the hindend is raised and usually bare. At the end of June large-scale production of larvae is observed.

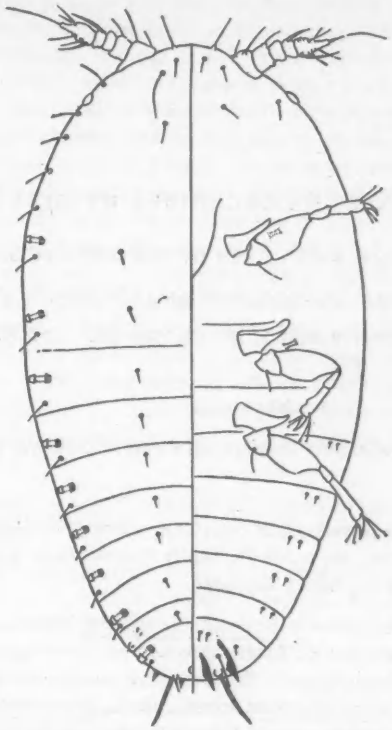

Fig. 3. Protancepaspis bidentata Borchs. et Bustsh., sp. n., 1st instar larva.

SUMMARY

Type Protancepaspis bidentata Borchsenius and Bustshik, sp. n.

This new genus is allied to Ancepaspis Ferris; the adult female differs from the latter in having pygidial marginal tubular ducts, some discoidal pores close to the anterior spiracles, some small tubular ducts close to the posterior spiracles, and in the anterior position of the anal aperture. The first stage larva differs from the Ancepaspis larvae in having 5-segmented antennae and thoracic marginal ducts.

Protancepaspis bidentata Borchsenius et Bustshik, sp. n.

Adult female. The body pear-shaped (Fig. 1), about 1.0-1.2 mm long. Anterior spiracles with a scattered group of 5-7 discoidal pores; behind the posterior spiracles there are 5-7 minute ducts. Ventrally in the middle part of the body there are some very small tubular ducts. Pygidium narrow, apically divided by a deep cleft into two large lobes (Fig. 2), with a central dorsal sclerotization. Marginal ducts all moderately large, there being four on each side of the pygidium. Anal opening relatively large, set posterior to the genital opening. Perivulvar pores present and forming a practically continuous arch.

Scale of the female composed of the swollen and sclerotized second exuvia, the first skin whitish, usually lost; secretionary material very sparse.

China, Szuch'uan Omeishan mountains southwest of Ch'engtu, on the young twigs and on the leaves of Rubus Parkeri Hance (Rosaceae).

NOTES ON THE COCCOIDEA OF CHINA

VI. DESCRIPTIONS OF NEW GENERA AND SPECIES OF COCCIDS (HOMOPTERA, COCCOIDEA, ERIOCOCCIDAE AND COCCIDAE). (SCIENTIFIC RESULTS OF THE SINO-SOVIET EXPEDITIONS OF 1955-1957 IN SOUTHWEST CHINA)

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The present paper describes: a new genus Physeriococcus, represented by a single species – Ph. cellulosus Borchs., sp. n., of the family Eriococcidae, 2 new genera – Dicyphococcus and Mitrococcus – and 5 new species of the family Coccidae.

Two species – Eulecanium nigrivitta Borchs., sp. n., and Luzulaspis crassispina Borchs., sp. n. – from the northern part of Yunnan Province are probably Palaeartic elements represented in the northeast zone of the Indo-Malayan region. The remaining new species – Mitrococcus celsus Borchs., sp. n., from Szuch'uan Province, Physeriococcus cellulosus Borchs., sp. n., Dicyphococcus bigibbus Borchs., sp. n., and D. ficicola Borchs., sp. n., from the southern part of Yunnan Province, evidently belong to the Indo-Malayan fauna.

The types of the new species are preserved in the Entomological Institute of the Academy of Sciences of the Chinese Peoples' Republic in Peking and the paratypes are preserved in the Zoological Institute of the Academy of Sciences of the USSR in Leningrad.

FAMILY ERIOCOCCIDAE

PHYSERIOCOCCUS BORCHSENIUS, gen. n.

Adult female. Spherical, outer integument of fully developed female strongly sclerotized; externally the female is very similar to females of the genus Kermococcus Silv. Antennae and legs reduced. Beak 2-segmented. Spiracles large. Anal lobes developed, but small. Anal ring with pores and 8 setae. Multilocular pores of varying dimensions and tubular ducts developed. Conical spurs confined to the margins of the apical abdominal segments. Dorsum of body with numerous polygonal and oval alveoli.

Male nymph cocoon tomentose, oval, similar to the male cocoon of the genus Acanthococcus Sign.

Type of genus – Physeriococcus cellulosus Borchs., sp. n., Yunnan.

Allied to the genus Nidularia Sign.; the females of the new genus are easily separable on external appearance by the globular body shape, the strongly sclerotized dorsal body surface, and the absence of an egg sac.

Physeriococcus cellulosus Borchsenius, sp. n. (Fig. 1,2).

Adult female. Body spherical, beige, often with darker transverse stripes, or light brown; dorsally with scattered conical wax spines (Fig. 1); 5.5 mm long, 5 mm wide, and 3.5 mm high. Antennae (Fig. 2, b) 2-3 segmented. Legs often in the form of small tubercles, middle and hindlegs sometimes 2-segmented and bearing long digitules (Fig. 2, c-e). Anal ring small, short, oval, 0.060 mm long, with minute pores and 8 setae. Anal lobes displaced to the ventral body surface, strongely sclerotized, bearing several spines and a stoute apical

seta 0.100-0.110 mm long. Multilocular pores (Fig. 2, b) with 7, 8, and 9 alveoli; on the inner side of each anterior spiracle there is a group of 2-7 pores; 2 groups situated between the posterior spiracles; one group on the outer side of each posterior spiracle; a linear group between the hindlegs and one group along the side of each leg; 5 transverse stripes and 2 groups located on the abdomen. Quinquelocular pores (Fig. 2, h) forming 2 linear groups between the posterior spiracles and one group on each side of the metathorax and abdominal segments (Fig. 2). Small dark-bordered pores (Fig. 2, i) approximately 0.006 mm in diameter, grouped into a submarginal band extending to the 3rd transverse row of multilocular pores on the abdomen. Tubular ducts of two sizes (Fig. 2, j, k), the largest 0.025 mm long. Multilocular pores present on the ventral body surface in transverse bands anteriorly on the abdomen and scattered on the submarginal zone of the head and thorax region medially. Spines (Fig. 2, 1) conical, grouped in a row along the edge of the posterior three abdominal segments. Dorsal body surface with numerous cells (Fig. 2, f), similar in form to the dorsal cells of Saissetia nigra (Nietn.), each cell with the opening of a small tubular duct within it.

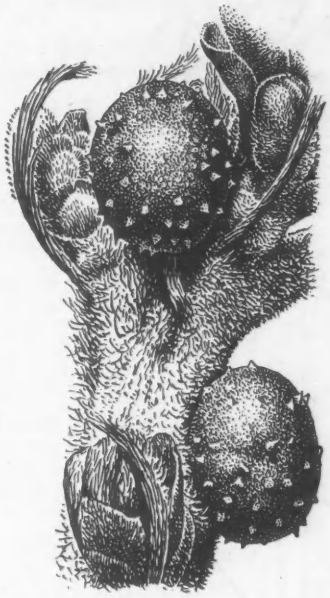

Fig. 1. Physeriococcus cellulosus Borchs, sp. n., adult females on an oak twig.

Male nymph cocoon white, smooth, flattened, 1.8 mm long and 1.0 mm wide.

China, Yunnan Province: forest 40 km south from the town of Szumao, March 27, 1957 (including the holotype ♀); forest 25 km north of the town of Chingtun on the bank of the River P'ap'engchiang (Black River), May 12, 1957, N. Borkhsenius. Lives on the young branches of oak (Fagaceae), but also found on braches of varying diameter and rarely on the trunk with thin bark. The flight period of the males was ending toward May 12; the females were not yet ovipositing.

FAMILY COCCIDAE

DICYPHOCOCCUS BORCHSENIUS, gen. n.

Adult female. Strongly convex, below oval, above laterally with slightly curved prominences, the body deeply convex between the prominences; body covered with a thin layer of dense wax, which is longitudinally divided into two parts; in addition, the apices of the prominences are covered with a conical plate; the entire integument with evident ridges running from top to bottom. Dead female dark brown. Antennae 6-7 segmented, the segments stout. Eyes located on the sides in front of the leve of the antennae. Beak 1-segmented. Legs developed, with stout segments. Anal fissure short. Anal plates elongated, with rounded outer angles. Anal ring developed, with 6 large bristles. Spiracles large, spiracular bands and often spiracular spines developed. A row of conical spines situated along the edges of the body. Tubular ducts of two types: small, with strongly sclerotized rims at the outer opening, and large, with weakly sclerotized rims at the outer opening; small ducts grouped in a marginal row or band and a band along the midline of the dorsal body surface, and also located in the submarginal zone of the venter; long tubular ducts located on the venter. Discoidal pores of one type; quinquelocular, rarely with trilocular ones among them. Circular pores of various sizes, observable on the dorsum. Body setae short, acute.

Male nymph scale covered with waxy plates.

Type of genus - Dicyphococcus bigibbus Borchs., sp. n., Yunnan.

Allied to the genus Parafairmairia Ckll., but the female of the new genus differs strongly in the shape of the body, antennae, and legs, in showing developed lateral spines, and in the structure of the integumentary pores and ducts. It is also related to the genus Cardiococcus Ckll., from which the females are distinguished by the developed legs and antennae, the absence of setae along the body margin, and also by the dark coloring of the waxy covering. Three species have been established.

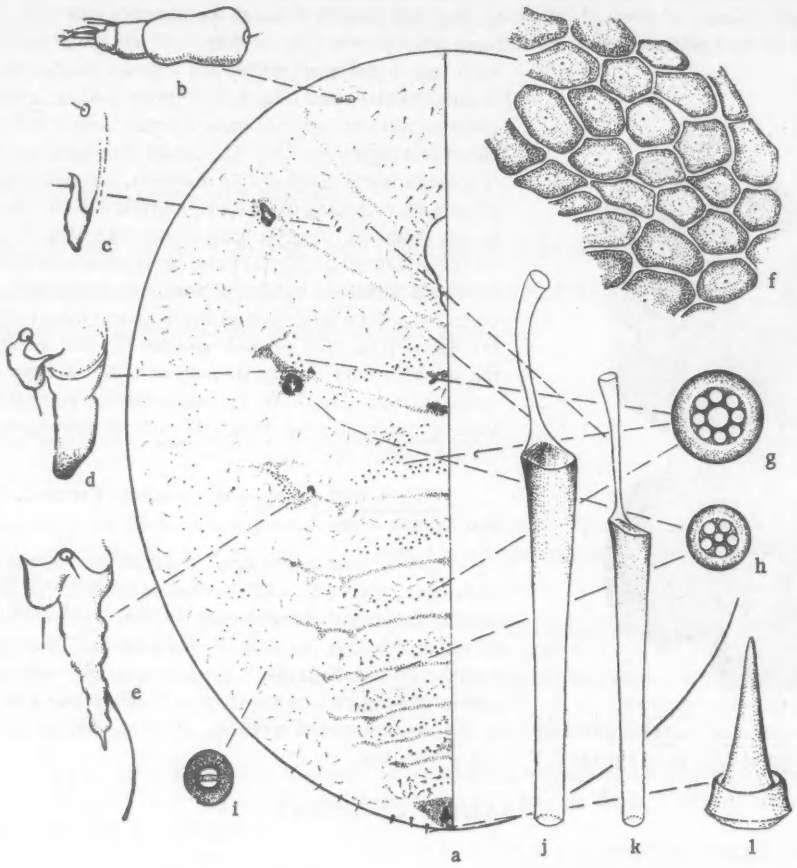

Fig. 2. Physeriococcus cellulosus Borchs., sp. n., female. a – Diagram of body; b – antenna; c – anterior leg; d – median leg; e – posterior leg; f – section of dorsal body surface ; g – multilocular pore; h – quinquelocular pore; i – dark-rimmed pore; j, k – tubular ducts; l – apical spine of abdomen.

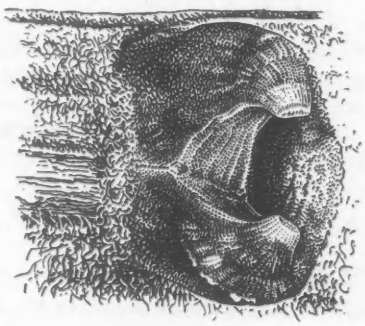

Fig. 3. Dicyphococcus bigibbus Brochs., sp. n., adult female.

Key to the Species

1 (4). Spiracular spines present.

2 (3). Intervals between marginal spines less than the diameter of the spines at the base; large tubular ducts 0.020–0.022 mm long . . . D. bigibbus Borchs., sp. n.

3 (2). Intervals between marginal spines approximately equal to the length of the spines; large tubular ducts 0.010–0.011 mm long . . . . . D. ficicola Borchs., sp.n.

4 (1). Spiracular spines absent . . . . . D. castilloae (Green).

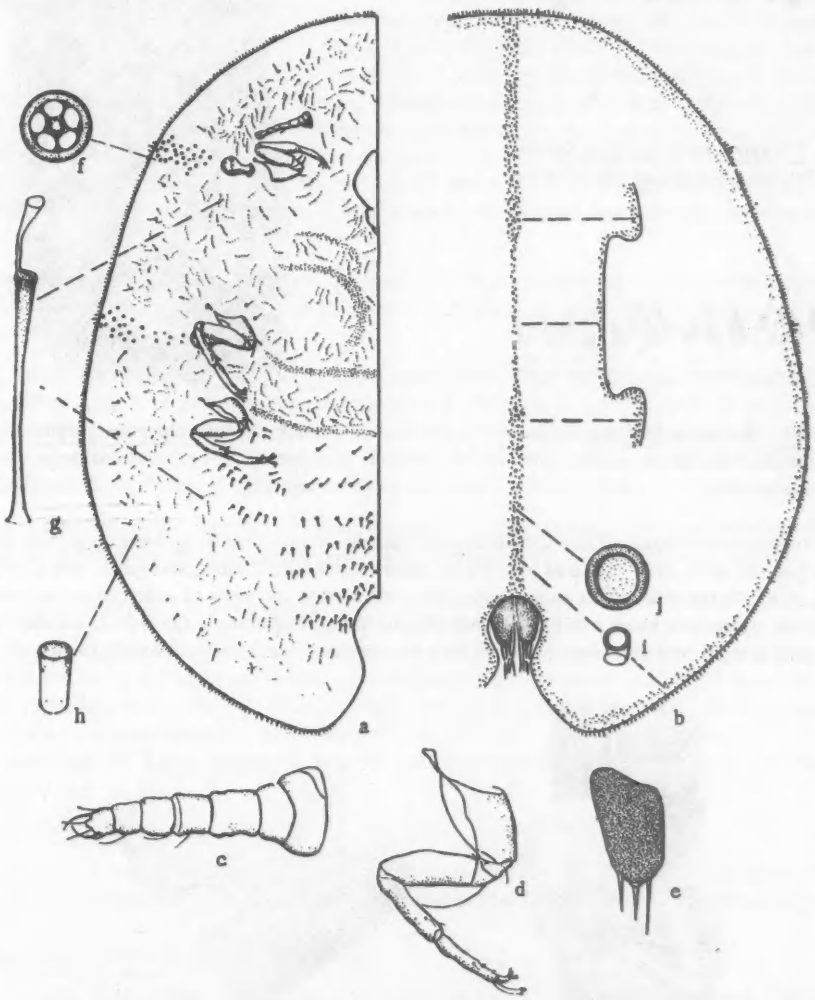

Fig. 4. Dicyphococcus bigibbus Borchs., sp. n., female. a – Ventral body surface; b – dorsal body surface; c – antenna; d – posterior leg; e – anal plate; f – quinquelocular pore; g, h, i – tubular ducts; j – discoidal pore.

Dicyphococcus bigibbus Borchsenius, sp. n. (Fig. 3-7)

Adult female (Fig. 4, a and b). Short-oval; specimens from Moghania covered with mat, brown wax (Fig. 3), from Cinnamomum with slightly shiny greyish brown wax; 3.3 mm long, 3 mm wide, and 2 mm high. Antennae 6-7 segmented (Fig. 4, c), 3rd segment considerably longer than the rest, sometimes divided into 2-

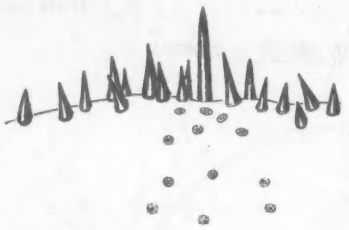

Fig. 5. Dicyphococcus bigibbus Borchs., sp. n., female. Spiracular and marginal spines.

Fig. 6. Dicyphococcus bigibbus Borchs., sp. n., female. Marginal spines and small tubular ducts.

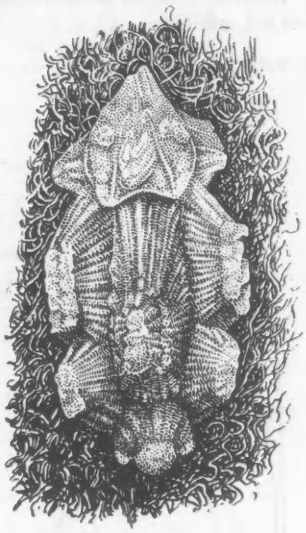

Fig. 7. Dicyphococcus gigibbus Borchs., sp. n., scale of male nymph.

segments, 1st segment very broad. Tibia a little longer than the tarsus (Fig. 3, d), tarsal digitules considerably broadened at the apex, claw digitules very broad. Anal plates with 2 elongated spines and a stout seta at the apex (Fig. 4, e). Spiracular orifice situated in a small depression the walls of which bear quinque- and hexalocular pores; spiracular bands consist of quinquelocular pores, beginning away from the spiracles, but reaching the body margin, 2-3 pores wide; the number of pores per band varies from 23 to 48; all spiracular

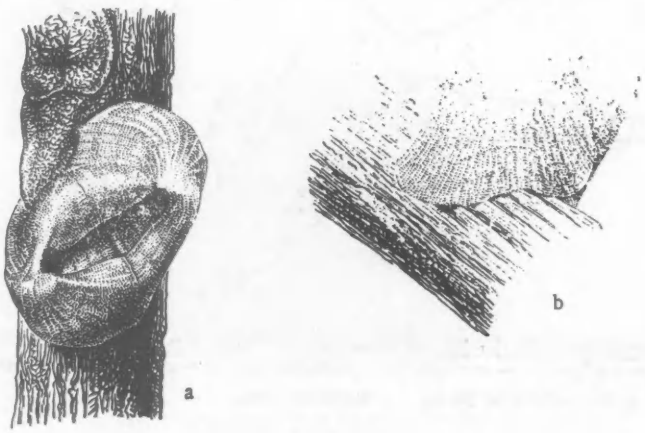

Fig. 8. Dicyphococcus ficicola Borchs., sp. n., adult females. a - Dorsal view; b - lateral view.

spines, except one, similar in form to the marginal spines, grouped together in a shallow depression of the body margin (Fig. 5). Marginal setae elongate-conical, apically acute, 0.016-0.022 mm long on the sides of the body, grouped into an irregular double row, the intervals between the spines less than the diameter of their bases (Fig. 5, 6). Small tubular ducts (Fig. 4, i) on the dorsal body surface approximately 0.002 mm in diameter; pores grouped into a narrow band parallel to the marginal row of spines and into a band along the midline of the body (Fig. 4, b); the latter extends from the head end of the body to the anal plates; at the end of the body the band divides, circumvents the anal plates, proceeds along the margin of the anal lobes, and merges with the pores of the marginal band. On the ventral body surface the sparse, small tubular ducts (Fig. 4, h) of the submarginal zone are grouped into a band 2 pores wide. The larger tubular ducts (Fig. 4, g), 0.020-0.022 mm long, are grouped into a broad longitudinal band aon the submarginal zone of the body, in transverse bands and groups on the middle of the thorax. Quinquelocular pores (Fig. 4, f) collected into small groups along the sides of the abdominal segments, a transverse band anterior to the vaginal opening, and two large groups along the side posterior to the opening. Large circular pores (Fig. 4, j) approximately 0.004 mm in diameter, running into the posterior section of the longitudinal row of tubular pores on the dorsal surface. Small tubular pores occasionally found on the dorsal surface. Setae short, acute, grouped into transverse rows on the middle of the abdomen.

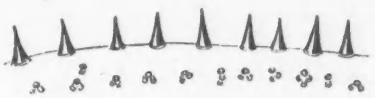

Fig. 9. Dicyphococcus ficicola Borchs., sp. n., female. Marginal spines and small tubular ducts.

Male nymph scale (Fig. 7) oval, convex, the waxy covering consisting of a large flat head plate, one central, strongly convex, backwardly directed plate, two pairs of lateral plates, and an anal plate; 2.5 mm long and 1.5 mm wide.

China, Yunnan Province: environs of Chingtun, mountainsides along the banks of the P'ap'engchiang (Black River) and its tributaries; June 26 (including the holotype ♀), May 2, and May 19, 1957, N. Borkhsenius. On young branches of Moghania sp. (Leguminosae), Cinnamomum sp. (Lauraceae), Melastoma sp. (Melastomaceae), and Wendlandia sp. (Rubiaceae). Fully developed females, not yet ovipositing, and male nymph scales were collected; the flight of the males had terminated and these were not collected.

Related to Dicyphococcus castilloae (Green) (Inglisia castilloae Green); the females of the new species are distinguished by the presence of spiracular spines and a greater number of small tubular ducts.

Dicyphococcus ficicola Borkhsenius, sp. n., (Fig. 8, 9)

Adult female. Larger than Dicyphococcus bigibbus Borchs., sp. n.; wax covering brown, shiny (Fig. 8), 4 mm long, 4 mm wide at the base, and 3 mm high. Spiracular bands consisting of 17-25 quinquelocular pores; one spiracular spine larger than the rest. Marginal spines elongate-conical, intervales between them equal to their length or somewhat exceedint it. Small tubular ducts along the margins grouped into a row, many of them with double ducts (Fig. 9). Large tubular ducts on the ventral surface 0.010-0.011 mm long. Otherwise similar to D. bigibbus, sp. n.

Male nymph scales not found.

China, Yunnan Province: Chingtun District, banks of the P'ap'engchiang, May 17, 1957 (including the holotype ♀), N. Borkhsenius. Lives on the twigs of various diameters of Ficus pyriformis Hook. (Moraceae).

MITROCOCCUS BORCHSENIUS, gen. n. (Fig. 10, 11)

Adult female. Very convex, oval below, above covered with a thin layer of dense wax. Antennae and legs rudimentary. Spiracles large, spiracular bands and spines absent. Anal fissure short, anal plates rounded laterally as in many Ceroplastinae. Marginal spines stout, located along the entire body margin.

Males and male nymph scales not found.

Type of genus - Mitrococcus celsus Borchs., sp. n., Szuch'uan.

Related to the genera Idiosaissetia Brain and Inglisia Mask., from which it is easily distinguished by the rudimentary, unsegmented legs, reduced antennae, the conical shape of the marginal spines and the absence of dorsal plates.

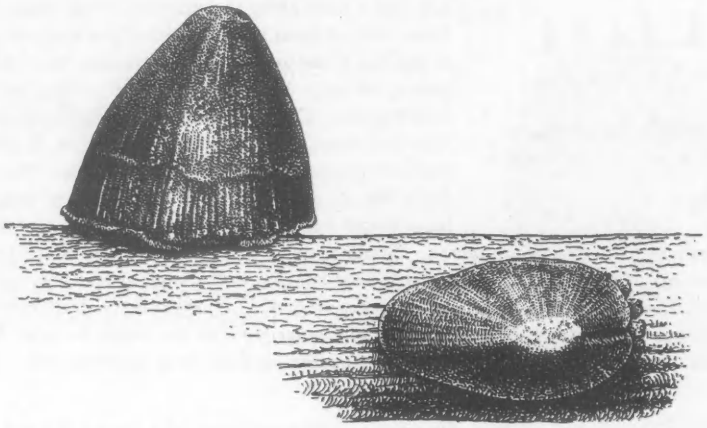

Fig. 10. Mitrococcus celsus Borchs., sp. n., adult females.

Mitrococcus celsus Borchsenius, sp. n. (Fig. 10, 11)

Adult female. Oval below, strongly convex, dark brown in dead females, shiny, covered with a fine, dense, greyish wax with metallic reflections, posteriorly with a deep longitudinal sulcus, the rest of the surface with fine radial stripes, the apex with an oval light patch (Fig. 10); 4.0-4.5 mm long, 2.0 mm wide, and 4.0-

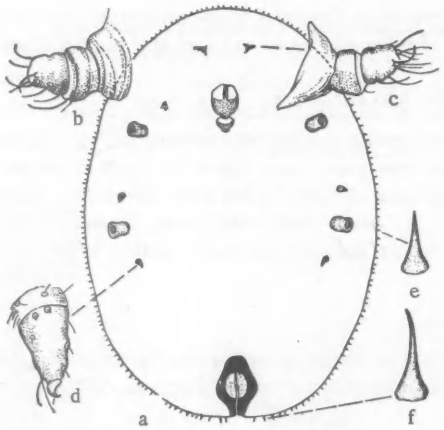

Fig. 11. Mitrococcus celsus Borchs., sp. n., female.
a – Diagram of body; b, c – antenna; d – hindleg;
e, f – spines of body margin.

4.5 mm high. Antennae 1-3 segmented (Fig. 11, b,c). Legs conical, with developed appendages (Fig. 11, d). Spiracles large, situated near the body margin, a group of discoid pores situated beside them. Anal fissure short, anal plates jointly oval in outline, anal ring small with long setae. Marginal spines stout, tapering above, acute (Fig. 11, e, f), 0.015-0.025 mm long; at the apex of the abdomen grouped into a row, along the rest of the body margin in 2 rows. Tubular pores forming a submarginal band; remaining pores absent.

China, Szuchuan Province: Omeishan Mountains, June 21, 1955 (including the holotype ♀), Sei Ta-lai and T. Bushchik. On the lower surfaces of the leaves, along the rachis, and on the small twigs of an undetermined plant.

Fig. 12. Luzulaspis crassispina Borchs., sp. n., female. Spiracular spines and marginal setae.

Outwardly, the females are similar to those of Inglisia conchiformis Newst., but in the latter the waxy covering is in the form of two valves and the legs and antennae are well developed.

LUZULASPIS CKLL.

Luzulaspis crassispina Borchsenius, sp. n. (Fig. 12)

Adult female. Elongated, fully mature female 6 mm long, dark yellow when alive, with two longitudinal dark red stripes, in some specimens these stripes indistinct. Antennae 8-segmented; bases of antennae situated closer to the bases of the anterior legs than to the cephalic margin of body; lengths of segments in microns: 1st – 45, 2nd – 48, 3rd – 80, 4th – 65-72, 5th – 55, 6th – 40, 7th – 33-40, 8th – 43. Legs slender. Articulation of tibia and tarsus strongly sclerotized; claw digitules very strongly broadened. Spiracles moderate in size, spiracular bands consisting of quinquelocular pores among which are some trilocular ones; anterior bands broad, 4-6 pores wide, made up of 47-55 pores; posterior bands narrower, 3-4 pores wide, consisting of 47-55 pores. Spiracular spines very stout, sometimes toothed or forked, straight or curved (Fig. 12), their length varying from

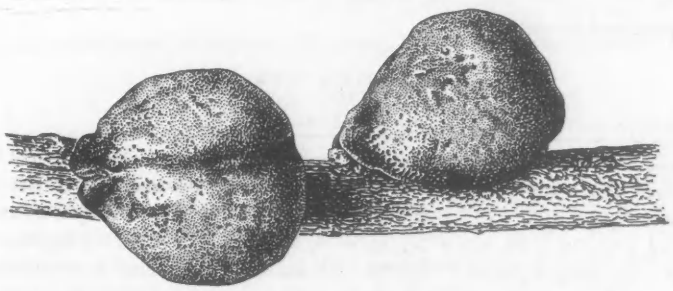

Fig. 13. Eulecanium nigrivitta Borchsenius, sp. n., females.

0.025 to 0.050 mm. Marginal setae uniform, slender, acute, 0.030-0.035 mm long; grouped into an irregular row in which the spines are partly staggered; along the sides of the body the intervals between the setae are approximately equal to the length of the setae; in large specimens the intervals considerably exceed the setal length; 14-15 marginal setae between the anterior and posterior spiracular spines. Multilocular pores collected into two groups along the sides of the anal fissure, into a curved band anterior to the vaginal opening, and into two small groups anteriorly along the sides of the bands. Tubular pores small, 0.012 mm long, scattered over the entire dorsal surface except for a space on the frons, on the submarginal zone of the ventral surface, and collected into groups and bands over the rest of the body. Body setae of varying lengths; dorsal body surface, where there are no tubular pores, with a large group of stout setae 0.050-0.060 mm long, the remaining setae 0.015-0.020 mm long; ventral surface with very large setae between the antennae and 4 on each abdominal segment, aside from the small setae.

Female egg case white, narrow, 10-14 mm long and 1.5-2.0 mm wide when fully developed.

Male nymph scales not found.

China, Yunnan Province: environs of Chingtung, in ravines in the shade of boulders, April 13 and May 14-18, 1957 (including the holotype ♀), N. Borkhsenius. On both surfaces of leaves of Carex sp. (Cyperaceae); the height of oviposition is observed in the middle of May, a few females by this time having terminated oviposition and left the egg case.

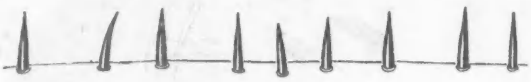

Fig. 14. Eulecanium nigrivitta Borchs., sp. n., female. Marginal spines.

Related to L. caricis Tak.; females are partly distinguishable by the greater body size, the larger number of quinquelocular pores in the spiracular bands, and by the approximately twice as long marginal setae.

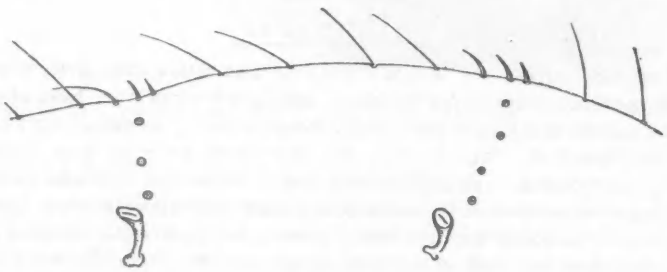

Fig. 15. Eulecanium nigrivitta, Borchs., sp. n., 1st instar larva. Spiracular spines and marginal setae.

EULECANIUM CKLL.

Eulecanium nigrivitta Borchsenius, sp. n. (Fig. 13-15)

Adult female. Irregularly globular with a somewhat prominent posterior end; yellowish brown, with a dark, longitudinal, concave band above and small punctures on the sides, the lower edges with a brown stripe (Fig. 13); up to 7 mm long, 7 mm wide, and 5 mm high. Antennae 6-segmented, lengths of antennals segments in microns: 1st - 22, 2nd - 22, 3rd - 85, 4th - 24, 5th - 24, 6th - 37; length of 3rd segment equal to the combined lengths of the 3 following segments. Legs, like the antennae, very small in comparison with the body; posterior femora 0.110 mm long at most, tibiae 0.075 mm, and tarsi 0.065 mm long; claw large, with a small tooth on the lower edge; digitules developed, slender. Peritreme of posterior spiracles 0.110 mm long. Anal ring with pores and with 8 setae. A row of acute spines 0.025 - 0.032 mm long the body margin (Fig. 14), the spines situated close to one another, the intervals between them less than their lengths.

1st instar larva. Oval, newly hatched larva 5 mm long. Antennae 6-segmented, lengths of antennal segments in microns: 1st - 15, 2nd - 22, 3rd - 44, 4th - 22, 5th - 24, 6th - 40. All segments bearing very long setae. Posterior femora 0.060 mm long at most, tibiae 0.060 mm, and tarsi 0.035 mm long; digitules on tarsus varying, one stout one situated behind a slender one; claw digitules also variable in thickness. Anal fissure short, seta of anal lobes long - 0.370 mm long; anal ring with 6 setae. Anterior spiracular bands consisting of 4 quinquelocular pores, the posterior of 5; 3 spiracular spines present in each of the anterior groups, 2 or 3 in each of the posterior; spines approximately 0.009 mm long and much shorter than the marginal setae (Fig. 15). Marginal setae stout, long; 9 setae 0.024-0.030 mm long situated on the frons between the eyes, 4 setae 0.028 mm long situated along each side of the body between the groups of spiracular spines; marginal setae on anal lobes 0.035 mm long.

China, Yunnan Province: environs of K'unming forest by the buddhist Temple of Ch'iungchuszu June 4, 1957 (including the holotype ♀), N. Borkhsenius. On the slender twigs of the oak Castanopsis (Fagaceae). The females laid eggs on April 4 and on June 9 the larvae hatched in large numbers. As is the case with the other representatives of the genus Eulecanium Ckll., the newly hatched larvae transferred to the leaves of the plant, where they became attached.

Related to Eulecanium sibiricum Borchs., and E. hissaricum Borchs. A general morphological characteristic of these species is a series of closely approximated marginal spines. The new species is easily separated from the other two by the strongly developed, dark, longitudinal depressed band which divides the surface of the female into two parts.

SUMMARY

FAMILY ERIOCOCCIDAE

PHYSERIOCOCCUS BORCHSENIUS, gen. n.

Adult female. Body globular, similar to Kermococcus Silv. Antennae and legs rudimentary. Anal ring with pores and eight setae. Multilocular pores of various sizes, quinquelocular pores, dark rimmed pores and large tubular ducts present. Conical setae confined to a marginal row on the last abdominal segments. Dorsal cuticle strongly sclerotized with polygonal and oval clear areas.

Type of genus – Physeriococcus cellulosus Borchs., sp. n.

The new genus is allied to Nidularia Sign.; it is distinguished from the latter by the globular body and strongly sclerotized dorsal cuticle, with polygonal and oval clear areas.

Physeriococcus cellulosus Borchsenius, sp. n. (Fig. 1, 2)

Adult female. Body about 5.5 mm long, 5 mm wide and 3.5 mm high. Small anal lobes and anal ring on the ventral side of the body. Anal lobe setae about 0.100–0.110 mm long. Multilocular pores with 7, 8 and 9 cells. Discoidal pores and tubular ducts situated as shown in Fig. 2. Conical setae on the three last abdominal segments.

Found on branches of oaks near Szumao and Chingtung, Yunnan province, March 27, May 12, 1957.

FAMILY COCCIDAE

DICYPHOCOCCUS BORCHSENIUS, gen. n.

Adult female. Body strongly convex, bilobed, the lobes laterally divergent, forming two irregular confluent cones, between the apices of which there is a deep furrow (Fig. 3, 8). Antennae 6- or 7-segmented. Legs small but well formed. With spiracular bands and often with spiracular spines. With a row of conical setae along the margin of the body. Small tubular ducts arranged in a submarginal band or row and in a longitudinal band middorsally. Quinquelocular pores, simple disc pores and large tubular ducts present.

Type of genus – Dicyphococcus bigibbus Borchs., sp. n.

The new genus is allied to Parafairmairia Ckll.; it is distinguished from the latter by the presence of well-developed marginal conical setae and by the structure of the cuticular pores and ducts.

Key to the Species of Dicyphococcus

1 (4). Spiracular spines present.

2 (3). Intervals between the marginal conical setae less than the base of the setae (Fig. 4, 5); large tubular ducts about 0.020–0.022 mm long. – China (near Chingtung, Yunnan province), on branches of Moghania, Cinnamomum, Melastoma, Wendlandia . . . . . D. bigibbus Borchs., sp. n.

3 (2). Intervals between the marginal conical setae about equal in length to the setae (Fig. 9); large tubular ducts about 0.010 mm long. – China (near Chingtung, Yunnan province), on branches of Ficus pyriformis

Hoke . . . . . D. ficicola Borchs., sp. n.

4 (1). Spiracular spines lacking. – Ceylon, on leaves on Castilloa, Grewia, Adenochlaena, Solanum, Vernonia, Thea . . . . . D. castilloae (Green).

MITROCOCCUS BORCHSENIUS, gen.n.

Adult female. Body strongly conves. Antennae and legs rudimentary. Spiracular bands and spiracular spines lacking. Anal cleft short; anal plates present. With a row of conical setae along the margin of the body.

Type of genus – Mitrococcus celsus Borchs., sp. n.

The new genus is allied to Idiosaissetia Brain and Inglisia Mask.; it is distinguished from these genera by the poorly developed antennae and legs, as well as by the presence of conical marginal setae.

Mitrococcus celsus Borchsenius, sp. n. (Fig. 10, 11)

Adult female. Body (Fig. 10) about 4.0–4.5 mm long, 2.0 mm wide and 4.0–4.5 mm high. Antennae segmented (Fig. 11). Legs conical, with digitules. Anal ring small with long setae. Marginal conical setae stout at the base and pointed (Fig. 11), 0.015–0.025 mm long.

Found on the underside of leaves and on the branches of an undertermined plant, Omeishan, Szuchuan province, June 21, 1955.

Genus LUZULASPIS COCKERELL

Luzulaspis crassispina Borchsenius, sp. n (Fig. 12).

Adult female. Body about 6 mm long. Antennae 8-segmented, situated at a point very much nearer to the bases of the front legs than to the frontal margin. Anterior bands of stigmatic pores 4–6 pores wide, each with 47–55 pores; posterior stigmatic bands with 47–74 pores. Stigmatic spines very stout (Fig. 12), 0.025 mm long. Marginal setae fine, about 0.030–0.035 mm long.

Ovisac white, narrow, 10–14 mm long, 1.5–2.0 mm wide.

Found on leaves of Carex sp. near Chingtung, Yunnan province, April 13, May 14 and 18, 1957.

This new species is allied to Luzulaspis caricis Tak.; it is readily distinguished from the latter the greater number of stigmatic pores and by the long marginal setae.

Genus EULECANIUM COCKERELL

Eulecanium nigrivitta Borchsenius, sp. n. (Fig. 13–15).

Adult female. Body irregularly globular, usually sloping more gradually on the posterior half of the body; brownish-yellow with a black median longitudinal stripe (Fig. 13); 7 mm long, 7 mm wide and 5 mm high. Antennae 6-segmented. Legs very small but well developed. Anal ring with pores and eight setae. With a row of marginal setae 0.025–0.032 mm long; intervals between the marginal setae less than the length of the setae.

Found on branches of Castanopsis sp. (Fagaceae), near K'unming, Yunnan province, April 4, 1957.

This new species is allied to Eulecanium sibiricum Borchs. and E. hissaricum Borchs.; it is distinguished from these species by the black median longitudinal strip.

A NEW SPECIES OF THE GENUS LUZULASPIS (COCCOIDEA, COCCIDAE) FROM CZECHOSLOVSKIA

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In the course of a study of the coccids of Czechoslovakia, we found a new species. Because of an insufficiency of comparative material we sent this species to N. S. Borkhsenius for determination. N. S. Borkhsenius confirmed our opinion that this was a new species.

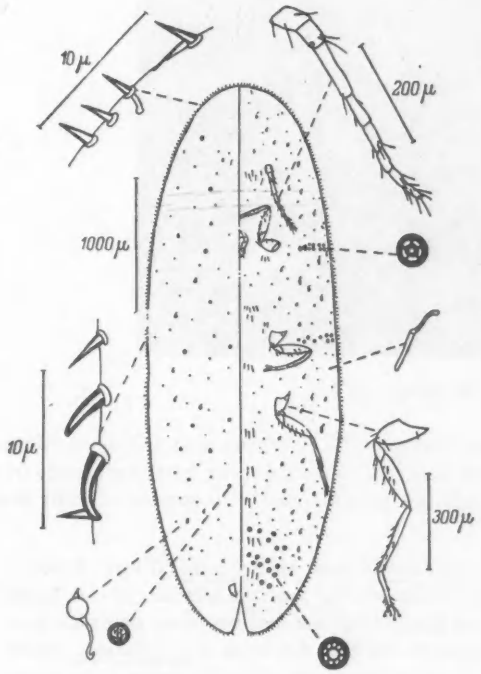

Fig. 1. Luzulaspis borchsenii, sp. n., female.

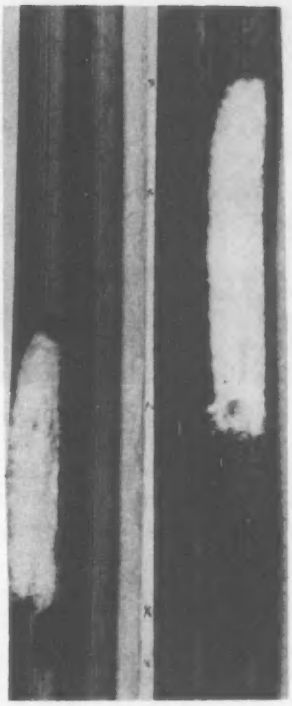

Fig. 2. Luzulaspis borchsenii, sp. n., female ovisacs.

Luzulaspis borchsenii Rehacek, sp. n.

Female ovisac white, narrow, almost parallel-sided, 5-8, more rarely up to 10 mm long and 1.0-1.5. mm wide.

Males and male numph scales not found.

Adult female. Elongate-oval, 3.0-5.5 mm long and about 1 mm wide in preservation. Upper surface: entire surface with numerous short tubular ducts and small circular pores; marginal setae spiniform, short, stout, acute; along the frontal margin of the head the intervals between them are less than the length of the setae, along the rest of the body margin these intervals are equal to or a little larger than the length of the setae; spiracular spines 2 in each group, stout, slightly curved, almost twice as long as the marginal setae. Lower surface: legs slender, long; antennae long, 8-segmented, length ratios of segments: 3, 4, 5, 8, 1, 2, 6, 7; antennal bases located approximately halfway between the frontal margin of the body and the bases of the coxae of the anterior legs; short and long tubular ducts present on the body surface, sparse quinquelocular pores present on the posterior 3 abdominal segments; spiracular bands consisting of 5-7 locular pores; abdominal sternites with long setae grouped into broad transverse bands.

Fig. 3. Habitat of Luzulaspis borchsenii, sp. n.

Habitat. On marshy soil on the leaves of Carex sp. near the Morava River between Kuty and Devin (Slovakia). In the middle of October, 1955, females and ovisacs were found; the majority of the females separated from the ovisacs after oviposition. Larvae were hatched from the eggs in almost all cases. The species is locally abundant in this area.

Luzulaspis borchsenii is related to L. montana Schmutt., L. datylis Green, and L. scotica Green. According to a communication from Dr. Schmutterer, the new species differs from L. montana Schmutt. by the length of the marginal setae, which are longer in L. borchsenii, and by the intervals between the setae, which are less in the new species. The spiracular spines in L. borchsenii are longer and finer then those of L. montana. From L. dactylis Green the new species is distinguishable by the shape of the spiracular spines, the ratios of the antennal segment lengths, and also by the shape of the legs and antennae, which are shorter and stouter in L. dactylis. From L. scotical Green the new species differs in the location of the antennae; in L. borchsenii these are located approximately halfway between the cephalic end of the body and anterior coxal bases, while in L. scotica they are located closer to the anterior coxal bases.

SUMMARY

In the course of studying the fauna of Coccids in Czechoslovakia a new species, Luzulaspis borchsenii, sp. n., living on Carex sp. near the river Morava (Slovakia), was found in 1955.

The main specific characters of this species are as follows: marginal setae thick, short and sharp, the interval between their bases on the frontal margin shorter than their length, that on the other margin approximately as long as their length or longer. Stigmatic setae two, simple, thick and approximately twice as long as the marginal setae. Antennae approximately midway between frontal margin and 1st pair of legs.

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* In Russian.

NEW AND LITTLE-KNOWN BRACHYRHYNCHIDAE (HEMIPTERA-HETEROPTERA)

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The present work, devoted to the family Brachyrhynchidae (= Dysodidae, Aradidae subfam. Mezirinae), is a survey of the family in the USSR with descriptions of a number of new genera and species from outside the Palaearctic Region – from the Malayan and Oriental regions.

At the present time, only four genera of the family are represented in the USSR, as well as in the entire Palaearctic: Calisius Stal, Mezira Am. Serv., Neuroctenus Fieb., and Aneurus Curt., while the world fauna in this family comprises 58 genera.

In my revision (Kirichenko, 1913), I postulated the presence of species of the genus Calisius in the Crimea or the Caucasus. This assumption has not yet been substantiated, but in is still in effect, bearing in mind the great difficulty involved in the discovery of these minute (2-3 mm) and flattened insects which imitate the color and pattern of their surroundings (they are encountered in the cracks and under the bark of trees). This assumption has been supported by the finding of the endemic species C. turanicus Kir., sp. n., in Central Asia (Amu-Dar'ya, Vakhsh, Murgab rivers, Tashkent).

In the fauna of the USSR the genus Mezira Am. Serv. is represented by 5 species (one new, M. verruculata Kir., sp. n.), all five of which are found in the deciduous forests of the Far East, one of which is common to the forest zone of Europe, with a wide interruption in its range throughout all Siberia. In Japan, an extremely small representative of the genus has been found – M. infantulus Kir., sp. n. – which is isolated into a special subgenus Mezirella Kir., subgen. n. In the author's revision (1913), only single individuals for the species of this genus were available, these having been collected by V. I. Dybovskii on the Ussuri River in 1874. This time abundant material has been recorded below for this genus from the southern Maritime Province. There remains at present an extreme and inexplicable paucity of literature data on the genus Mezira (as well as on the family as a whole) in Japan, where the one endemic species Mezira (in sp.) scabrosa Scott and the above-mentioned M. (Mexirella) infantulus Kir., sp. n., are known.

The genus Neuroctenus Fieb. is represented by a large number of species (41), known primarily from the Oriental (10), Neotropical (12), Ethiopian (9), Malagasy (3), Australian (4), and Nearctic (4) zoogeographical regions. The genus is absent in Europe, but Mezira atra Yak., 1878, described by V. E. Yakovlev and redescribed by me (1913), from the Far East, is placed in the genus Neuroctenus by Bergroth on the basis of the illustration of the terminal abdominal segments of the ♀ in my paper.

The systematic position of Neuroctenus ater (Yak.) and N. macer Kir., sp. n., described in the present work, requires further investigation in connection with the genus they should belong to.

The genus Aneurus Gurt. includes 40 species so far described; the greatest specific representation is observed in the Neotropical (9) and Oriental (8) zoogeographical regions. Three species are known from the USSR, of which A. macrotylus Yak. is found in the Far East, one (A. laevis F.) has a European, and the other (A. avenius Duf.) has a European and Siberian distribution, including also the Far East.

Several works on the group here investigated were unavailable to the author and not utilized in the paper, such as those of Kormilev (1953) and Usinger (1950).

Calisius turanicus Kirichenko, sp. n. (Fig. 1)

Calisius sp. Kirichenko, 1931, Pamir Expedition of 1928. Transactions of the Expedition, VIII, Zoology: 107, 110; Kirichenko, 1936, 1953, in: Fauna of the USSR, I: 459; IV: 488.

Calisius turanicus Kir. Kirichenko, 1948, in: Fauna of the USSR, II: 250 (nom. nud.).

Head equal in length to the pronotum, its anterior process massive, stout, extending beyond the base of the apical antennal segment; anteocular processes acute, obliquely directed outward, extending to the apex of the 1st antennal segment, postocular ones short, obtuse, scarcely higher than the middle of the eyes. Antennae very short, somewhat longer than half the head length; 1st antennal segment cylindrical, twice as broad as the 2nd and shorter by 1/5; 2nd and 3rd short-oval, the 3rd somewhat shorter and slenderer than the 2nd; 4th broadly oval, quite flattened, longer than the 2nd and 3rd together, and at least 4 times as stout as the 2nd. Head surface coarsely granulate, with two obtuse carinae behind the anterior process which diverge anteriorly and are provided with large, acute tubercles. Pronotum narrowed anteriorly, its posterior margin 1/3 wider than the anterior, the lateral margins with a very weak concavity almost straight, bearing large obtuse teeth, the dorsum medially with two median crests diverging posteriorly and bearing tubercles which are often pale, those along the anterior border larger and more salient, the two lateral crests less rugose. Scutellum elongate and linguiform, its lateral margins with a short median concavity, their anterior half margined, the surface at the base with a triangular raised area along the sides of which oblique impressed areas are observed, these being lighter colored, the median carina arising from the apex of this raised area and extending to the apex of the scutellum, becoming slightly less raised; disc of scutellum densely and evenly covered with small, colorless, impressed punctures and scattered brown spots on the apical half. Connexiva finely toothed, with a broad yellowish stripe. Legs brown, with only the apices of the femora whitish.

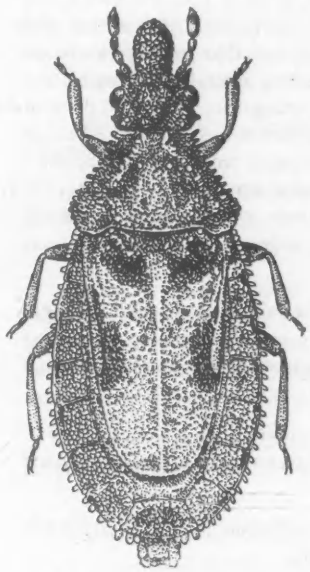

Fig. 1. Calisius turanicus Kir., sp. n.

♂. Length 2.8-2.9 mm; width of pronotum posteriorly 0.9-1 mm; width of the abdomen 1-1.1 mm.

♀. Length 3-3.6 mm; width of pronotum posteriorly 1-1.2 mm; width of abdomen 1.1-1.3 mm.

Southern Tadzhikistan: Fomkin Creek natural boundary, Tigrovaya Gorge, lower reaches of the Vakhsh River, June 28, 1941 (2♀♀; Gussakovskii), in the cracks in the bark of Populus pruinosa Schrenk.

On the basis of the structure of the 2nd and 3rd antennal segments this species is closely related to the Mediterranean C. ghilianii Costa.

This is an ancient relic of the Turanian fauna and the sole representative of the genus in the USSR. Of the rather numerous (19) species of Calisius the majority belong to the Australian fauna (7 species), of which 1 is on the Australian content, 1 on Tasmania, 4 from New Guinea, and 1 from the Fiji Islands, to the Neotropical (3 species), to the Ethiopian (3 species), to the Nearctic (4 species), and only two to the Mediterranean subregion of the Palaearctic Region. C. turanicus Kir., sp. n., was found previously by A. M. Gerasimov in the valley of the middle course of the Amu-Dar'ya, at Mangit, June 5, 1929, in the cracks of the bark of an old willow; he also found it in northwest Uzbekistan: at Buston, May 9-10, 1928, on poplar; in Turkmenia: at Iolatan', Murgab Valley, June 7, 1936 (♂♀; Kizeritskii), and, finally, in Tashkent, 1944, in Pushkin Park, under the bark of a plane tree (2♀♀; Arkhangel'skii).

The pattern of geographical distribution of the species in this genus and the fact that the various species are extremely poorly differentiated demonstrate the undoubted antiquity of the genus.

Mezira patruelis Kirichenki, sp. n.(Fig. 2)

Coal black, large, widening posteriorly, with straight sides, which are broadly rounded in the ♀.

Head as long as wide, including the eyes, the anterior process reaching 3/4 the length of the 1st antennal segment, slightly narrowing anteriorly, weakly bifurcate apically; tubercles bearing the antennae short, somewhat exceeding the base of the 1st antennal segment, obtusely pointed, directed straight forward or slightly laterally, parietal processes falciform, short and broad, head surface coarsely granulate, uniformly colored. Antennae short, stout; 1st segment basally bent and here only narrower than the remaining part of the segment; 2nd almost twice as long as the 1st, becoming gradually broader from the base to the apex where it is swollen like a club; 3rd 1/4 to 1/5 longer than the second and twice as long as the 4th, gradually and evenly widening from base to apex so that it is twice as wide as the apex as at the base; 4th spindle-shaped, equal in length to the 1st.

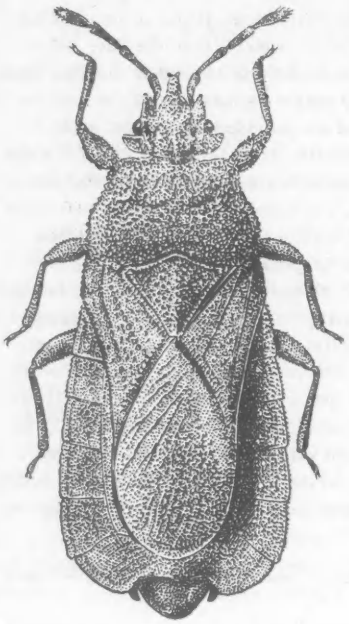

Fig. 2. Mezira patruelis Kir., sp. n., ♂.

Pronotum transverse, its length shorter by 1/4 than that of its width and almost twice as long as the scutellum, its anterior border straight except for the forward-projecting anterolateral angles, its posterior border broadly and deeply emarginate in front of the scutellum, the lateral margins broadly emarginate before the middle, dentate for their entire length, the hind angles projecting beyond the sides of the scutellum. Surface of pronotum densely granulate, even, with a shallow transverse impression only at the center. Scutellum and equilateral triangle, transversely rugose, with an effaced, weak median carina.

Hemelytra uniform in color, the membrane weakly shining, darker than the corium, extensively granulated between the veins; the hemelytra reach the apical margin of the pregenital abdominal segment.

Connexivum broad, uniformly colored, the apical angles of the segments barely projecting, the lateral margins indistinctly and finely serrate.

♂. Length 10-10.1 mm, width of pronotum posteriorly 3.5-3.4 mm; width of abdomen 4-4.4 mm.

♀. Length 10.2-10.6 mm, width of pronotum posteriorly 3.3-3.4 mm, width of abdomen 4.2-5 mm.

Island of Madagascar: Perinet, 950 m, December 1932 (3 ♂♂, 1♀), January 16, 1934 (1 ♂); Anamalasotra, November 1930 (3 ♂♂), November-December, 1930 (1 ♀) (G. Olsuf'ev).

On the basis of the shape of the pronotum with the deeply emarginate hind margin it belongs to the section M. membranacea F., widely distributed in southeast Asia, but it is easily distinguished from this species by the membrane of the hemelytron, which is densely granulate.

Mezira tremulae Germ.

Since my monograph (1913), a number of works have appeared which discussed the centers of preservation of this disappearing species in western Europe and the western sections of the USSR (Schumacher, 1919; Lundblad, 1921; Krasucki, 1923). The material present in the collections of the Zoological Institute, AN SSSR, gives the following representation of the distribution and phenology of this species.

Belorussia: Koshelev forest, April 21, 24, 30, June 29, July 2, 1923, under the bark of an aspen log, in a rotten aspen log without bark, in rotten aspen wood, on the bark of a birch stump (15 ♂♂, 19 ♀♀, 8 larvae; D. Pomerantsev).

Khrenov forest, Voronezh Region, August 7, 1928, rotten aspen (Z. Onisimova).

Zhiguli preserve on the middle Volga, June 20, 1937 (♂; E. Novoderezhkin); Buzuluk forest, May 1, 1941 (1 ♂, 2 larvae), under the bark of an old aspen stump (A. Chitovskii).

Kiev; Zmiev on the northern Donets, August 24, 1932 (1 ♂; 3 ♀♀; K. Arnol'di); Markovichi, Volyn Region, March 23, 1906 (3 ♀♀; G. Olsuf'ev).

Northern Caucasus, Guzeripl' on the Belaya River, March 28, 1927 (2 ♂♂, 1 ♀; P. Slashchevskii); Bogatyrka, 5 km from Sevastopol'skaya, Maikop Region, March 28, 1927 (2 ♂♂, 2 ♀♀, larva; P. Slashchevskii); Zmeiskaya, Kabardinskaya ASSR, June 25, 1920 (1 ♀; M. Ryabov); Paraboch' forestry station, left bank of the right fork of the Terek, July 13, 1927 (19 ♂♂, 13 ♀♀, 4 larvae; A. Kirichenko); Karayazy, Gardaban Region, March 16, 1916 (1 ♀; V. Kozlovskii); Belokany, western Azerbaidzhan, August 6, 1928 (1 ♀; Bocharnikov).

Maritime Province,*: Chernigovka, June 7, 1912 (1 ♀; E.); Upper reaches of the Suputinka, tributary of the Suifun, June 20, 1936 (1 ♂; S.); middle course of the Suputinka, June 3, 1938, on cedar (1 ♀; S.), June 20, 1949 (3 ♂♂, 1 ♂♂, 1 ♀; Kur.); Suputinka River, reservoir, June 28 (1 ♂, 1 ♀), July 2 (1 ♂), 1940 (L.); Yakovlevka, Lazarev road, May 23 (4 ♂♂, 12 ♀♀), June 5 (1 ♂), July 22 (1 ♂, 4 ♀♀), 1926 (D. and F.); Vinogradovka, June 4 (1 ♂) and 5 (1 ♀), 1929 (K.); Kangauz, foot of Padan Hill, June 27, 1928 (1 ♂; Rost.); Shkotov Region, River Maikhé, July 28, 1931 (♀; M.); Vladivostok, River Lyanchikhé, June 10, 1949 (2 ♂♂; Kur.); Tigrovaya, Suchan Region, September 17, 1928 (2 ♂♂, 1 ♀; P.).

Poland — Pulawy, hornbean forest along the road to Kazimir, June 22, 1909 (8 ♂♂, 7 ♀♀, 6 larvae; D. Smirnov).

There are no reference in the literature (Oshanin, 1908; Kirichenko, 1913) to the occurrence of this species in Kryshgatska, upper Dnestr, opposite Zaleshchnikov, Ternopol'skaya Region (Krasucki, 1923) and on the west shore of the San River in Peremyshl'.

Thus, the distribution of M. tremulae Germ. may be represented in the following manner: USSR — Prebaltic, Poles'e, Volynsko-Podol'skaya elevation, region of the Prevolga elevation, central forest-steppe zone, forest-steppe piedmont of the Donets Range, forest-steppe zone of the Transvolga, northern Caucasus, Dagestan, forest province of Transcaucasia, Far Eastern territory; western Europe — Sweden, Poland, Germany (Saxony, Brandenburg, Schleswig-Holstein), Hungary, Czechoslovakia, Italy, Yugoslavia.

The species is located and rare throughout, but was repeatedly observed in numerically large populations. It does not occur in the Crimea; there is a wide gap from the Transvolga to the Maritime Province.

Mezira basalis (Fieb.)

This second species of the genus Mezira in the European hemipterous fauna is poorly known up to the present.

It was described by Fieber of Andalusía. It is known (Reuter, 1890 : 241) from Greece (Paranassus).

Mezira setosa Yak.

Iman Region, July 9 (1 ♀) and 20 (1 ♂), 1931 (Sh.); Chernigovka, April 28, 1914 (1 ♂; E.); Odarka River valley, 25 versts from Evgen'evok, May 19 (1 ♂, 2 ♀♀), 22 (1 ♂), 31 (1 ♀), June 28 (1 ♀), July 27 (1 ♀), August 30 (1 ♂, 1 ♀), 1911 (Ch.); Yakovlevka, Kvashuka apiary, May 7 (2 ♀♀), 27 (1 ♀), 1926 (D. and F.); Yakovlevka, Andreev Road, May 4, 1926 (7 ♂♂, 9 ♀♀; D. and F.); Yakovlevka, forest by the River Shitukhé, May 21, 1926 (1 ♀; D. and F.); Vinogradovka, May 8 (1 ♀), 14 (1 ♀), 20 (4 ♂♂, 1 ♀), 27 (35 ♂♂, 40 ♀♀), 28

*The investigation of the families Aradidae and Brachyrhynchidae of the Far East was carried out by the expeditions of the All-Union Institute of Plant Protection under V. N. Stark, by expeditions of the Zoological Institute of the Academy of Sciences of the USSR, and by other investigators (A. I. Cherskii and others); their surnames are abbreviated as follows: V. M. Berger (B.), V. Vereshchagin (V.), A. M. D'yakonov (D.), A. A. Emel'yanov (E.), A. I. Ivanov (I.), A. N. Kurentsov (Kur.), A. L. Mishin (M.), A. K. Mordvilko (Mordv.), P. M. Pravdin (P.), V. G. Prinada (Pr.), P. D. Rezvoi (R.), A. P. Rimskii-Korsakov (R.-K.), A. A. Rikhter (Rikht.), B. Ya. Rostovykh (Rost.), S. V. Rysakov (Rys.), T. P. Samoilov (S.), N. N. Filip'ev (F.), A. I. Cherskii (Ch.), V. V. Shabliovskii (Sh.), N. I. Shingarev (Shing.), A. A. Shtakel'berg (Sht.).

(2♂♂, 2♀♀), June 2, (1♀), 4(1♂), 5(9♂♂, 19♀♀), 7(1♂), 1929 (K.); Suifin Region, June 26, 1930 (1♀; Sh); River Suputinka, tributary of the Suifun, reservoir, June 26, 1940 (3♂♂, 4♀♀; I.); middle course of the Suputinka, June 9, 1935 (1♀; S.); Voroshilov, June 1, 1925 (1♂; 1♀; S.); Bol'shaya El'duga River, May 31, 1930 (1♀; S.); Shkotovo Region, July 28, 1931 (1♀; M.); Shkotovo, June 7, 1929 (2♂♂; Sh.); Sedanka, July 5, 1914 (4♂♂, 2♀♀; B.); Okeanskaya, September 6 (1♀), 7 (3♂♂, 6♀♀), 8 (1♀), 1932 (Rys.); Vladivostok, June 22, 1927 (2♂♂; P.); north side of the bay of Zolotoi Rog, May 28, 1910 (1♂; B.); forestry station along the Maikhé, June 2, 1929, Quercus mongolica wood shipment (1♂, 2♀♀; Sh.); June 5, 1929 (1♀; Sh.), August 4, 1941, on Picea ajanensis deadwood (1♀; M.); Chernaya Rechka, August 2, 1925 (1♀; Rost.); August 9, 1925 (22♂♂, 23♀♀; Rost.); Russkii Island, June 24–July 10, 1928 (1♀; Pr.); Askol'd Island, June, 1918 (1♂, 1♀; Pr.); Derzhanovo, Suchan Region, June 20, 1927 (5♂♂, 8♀♀; V.); Kedrovaya pad', June 18, 1926 (1♂; Rost.).

Mezira verruculata Kirichenko, sp.n. (Fig. 3)

♂,♀. Large, almost quadrangular, slightly broadening posteriorly, dark tan colored except for the lighter corium of the hemelytra and a yellowish band along the hind edges of the abdominal segments.

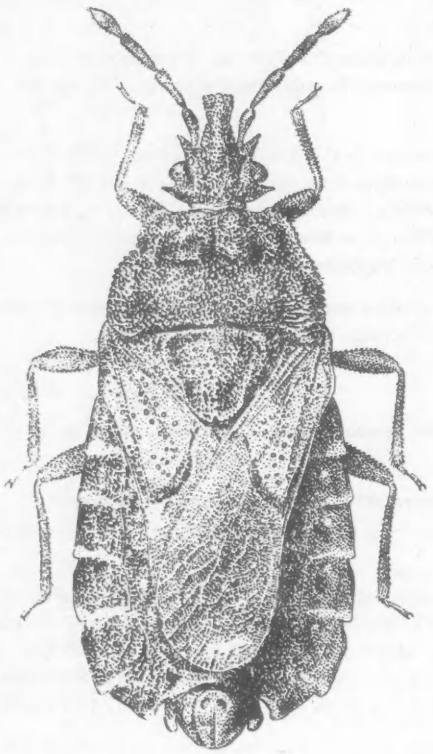

Fig. 3. Mezira verruculata Kir., sp. n., ♂.

Head longer than wide, the eyes included, its anterior process slightly extending beyond the base of the 2nd antennal segment, anteriorly broadening, the apex truncated, not bifurcated; prominences bearing the antennae short, acute, obliquely directed out; parietal processes short, barely extending beyond the eye orbits. Dorsal surface coarsely tuberculate, black laterally, with a broad reddish band medially. Antennae stout, 1st segment subcylindrical, 1/3 shorter than the 2nd; 2nd spindle-shaped, gradually broadening from base to apex; 3rd 1/4 longer than the 2nd, distinctly broader, slightly broadening from base to apex; 4th less than half as long as the 3rd, narrowed basally and apically, the apical third pale, yellowish white. Antennal surface finely granulate, bearing short setae, except for the apex of the 4th segment, which bears rather long, pale setae.

Pronotum twice as wide basally as long, equal in length to the head, the anterior margin broadly emarginate, lateral margins excised in an obtuse angle anterior to the middle, finely toothed, posterior margin broadly and shallowly emarginate, the anterior angles rounded. Surface of pronotum anterior to the middle with a deep transverse depression dividing it into two lobes, of which the anterior bears two smooth black areas and a longitudinal sulcus and the posterior is evenly granulate.

Scutellum equal in length to the pronotum, somewhat longer than its width at the base, the lateral margins medially emarginate, the apex broadly rounded, the basal angles and the middle of the basal margin with prominent yellowish white tubercles, the median one in the form of a short, obtuse carina. Surface of scutellum transversely rugose

Corium of hemelytra a dirty yellowish white with a black stripe along the raised apical edge, the surface between the veins covered with minute tubercles. Membrane with bronzy irridescence.

♂. Length 7.6 mm, width of pronotum posteriorly 2.5 mm, width of abdomen 3-3.3 mm.

♀. Length 8.5 mm, width of pronotum posteriorly 2.3 mm, width of abdomen 3.8 mm.

Voroshilov, June 1, 1925 (1 ♂, 1 ♀; S.); Suifun Region, May 26, 1930 (1 ♂; Sh.); Vinogradovka, May 27, 1929 (2 ♂♂; K.); Russkii Island, June 24— July 10, 1928 (1 ♀; Pr.).

Mezira verrucigera Bergr.

This species was known only from the Amur, from the Ussuri Krai, and from Sumatra without any definite locality (Kirichenko, 1913).

The new localities in the southern Maritime Province are as follows: Odarka River valley, 25 versts* from Evgen'evko, June 2, 1911 (1 ♂; Ch.); Vinogradovka, June 4 (12 ♂♂, 15 ♀♀), 5 (♂), 1929 (K.); Suputinka River, May 15, 1948 (1 ♂, Kur.); Krivoi Klyuch, tributary of the Suputinka, July 21, 1928 (2 ♂♂, 2 ♀♀; S.); Sedanka, June 10, 1926 (1 ♀; Mordv.); Maikhinskoe forestry station, June 2, 1929, Quercus mongolicallumber shipment (3 ♂♂, 2 ♀♀; Sh.); Russkii Island, June 24—July 10, 1929 (4 ♂♂, 4 ♀♀; Pr.).

Mezira castanea Yak.

The literature data published so far on the range of this species is insignificant: Ussuri River, 48°. N. lat. (V. Dybovskii), Vladivostok.

In the material available at the Zoological Institute of the Academy of Sciences of the USSR this species is represented as follows: middle course of the Amur, Birobidzhan, Bol'shaya Churka range, August 2, 1931 (1 ♂; Pr.); Aleksandrovka, June 28, 1931 (2 ♂♂, 1 ♀; Pr.). Maritime Province: Iman Region, May 13, 1911 (1 ♀; Shing.); middle course of the Malaza, August 7, 1931 (1 ♂, 5 ♀♀; Kur.); Samarga River, north slope of the Sikhoté-Alin' range, August 3, 1925 (11 ♂♂, 6 ♀♀, 3 exuv.; Kuzm.); Yakovlevka, forest along the flood-plain of the Daubikhé, May 10, 1926 (1 ♀; D. and F.); Odarka River valley, 25 versts from Evgen'evka, June 11, 1911 (1 ♀; Ch.); Vinogradovka, May 20 (1 ♀), 27 (1 ♂), 28 (1 ♂), June 5 (2 ♂♂, 6 ♀♀), 1929 (K.); middle course of the Suputinka, trib. of the Suifun, June 11, 1935, on Tilia amurensis (5 ♂♂, 2 ♀♀; S.), June 10 (1 ♂), 20 (1 ♂), 1949 (Kur.); Krivoi Klyuch, tributary of the Suputinka, June 2 (1 ♂, 1 ♀), 14 (4 ♂♂, 1 ♀), 29 (2 ♂♂), 1938 (S.), July 5 (1 ♀), 10 (3 ♂♂), 11 (23 ♂♂, 19 ♀♀), 12 (5 ♂♂, 2 ♀♀), 16 (1 ♂), 1937 (Rikht.). Vladivostok, Forestry station in the Maikhé River region: May 20 (2 ♀♀), under the bark of a Quercus mongolica trunk, June 2 (16 ♂♂, 19 ♀♀), Quercus mongolica wood shipment, June 13, 1931, under the bark of a felled oak (♂, 4 ♀♀; M.), June 14, 1930 (1 ♂, 1 ♀; M.). Shkotovo Region, June 5, 1931 (3 ♂♂, 10 ♀♀), under bark of Quercus mongolica (L.); Shkotovo, June 7, 1929 (4 ♂♂, 7 ♀♀; Sh.); River Maikhé nr. Shkotovo, June 6, 1937 (1 ♀; Sht.); Tigrovaya, June 9, 1927 (1 ♀; R.).

Northeast China: Siao-Lin, May 27, 1912 (1 ♀; D. Keller).

Mezira lieftincki Kirichenko, sp. n. (Fig. 4)

♀. Small, strongly flattened, dark brown, with yellowish white spots only on the outer apical angles of the membrane.

Head longer than its width including the eyes, somewhat shorter than the pronotum, the anterior process extending beyond the base of the 2nd antennal segment, weakly broadened toward the apex, bilobate apically, tubercles bearing the antennae short and broad, extending only to the 1/3 point of the 1st antennal segments, barely diverging outwardly, parietal processes short, acute. Hindmargin of the head straight. Antennae short, black; their 1st segment strongly narrowed at the base and broadened toward the apex; 2nd segment shorter than the first by 1/4, gradually narrowing from apex to base; 3rd slenderer than the 2nd, twice as long, gradually broadening from base to apex, but apically still less than half as broad as the apex of the 2nd; 4th segment the shortest, clavate at the apex.

Pronotum $2^1/_2$ times as wide as long between the hind angles, the lateral margins with a poorly defined emargination, the anterior angles obtusely angled and rounded, dorsum of pronotum with no transverse depression, evenly granulate.

Scutellum an equilateral triangle, equal in length to the pronotum, the lateral margins straight, the surface transversely rugose, with a barely perceptible longitudinal carina on the apical half.

* Verst – a Russian measure of length, equal to 0.6629 mile, or 1.067 kilometers.

Hemelytra, except for the pale spots behind the apical margin of the corium, uniformly colored, the corium evenly covered with dark tubercles, membrane dark, the veins black, distinctly thickened, forming a dense network of anastomoses.

Connexivum wide, uniformly colored, the apical angles of the segments not projecting.

Femora provided on the upper and lower surfaces with short acute teeth, the tibiae bearing these only on the upper surface, where they are shorter and more scattered.

Length 7 mm, width of pronotum posteriorly 1.8 mm, width of abdomen 2.4 mm.

Mountains of western Java: Idjen, 250 m, Blavan (1 ♀; Dammerman).

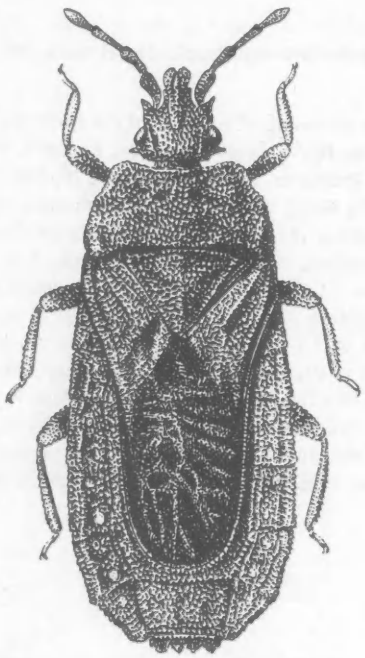

Fig. 4. Mezira lieftincki Kir., sp. n., ♀.

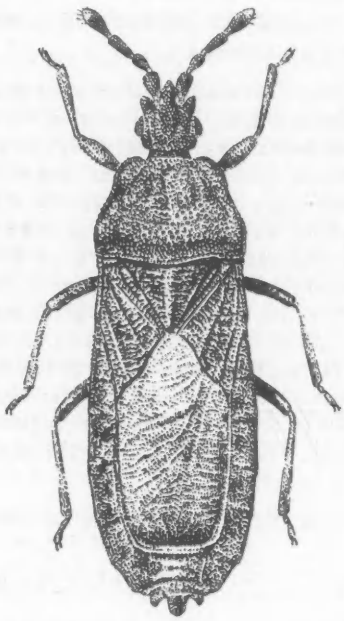

Fig. 5. Mezira (Mezirella) infantulus Kir., sp. n., ♀.

Mezira infantulus Kirichenko, sp. n. (Fig. 5, ♀)

The smallest species of the genus, the family, and the series Phloeobiotica. Body not broadening posteriorly, almost parallel-sided. Reddish brown. Head barely shorter than the pronotum, its anterior process extending a distance of 1/4 along the 1st antennal segment, equally long as wide; no postocular processes, the head narrowing to the base behind the eyes. Antennae shorter than the head and pronotum combined by 1/4; 1st segment the broadest, bean-shaped, narrowed only at the base in the form of a stalk, extending for more than half its length beyond the apex of the anterior cephalic process; 2nd segment 1/2 as long as the 1st and 1/3 as long as the 3rd; its length equal to its width; 3rd segment slenderer than the others, slightly broadening from base to apex, 1/4 longer than the 4th; the latter spindle-shaped, twice as broad at the apex as the base.

Pronotum trapezoid, the anterior margin straight, the lateral margins very slightly emarginate, the posterior margin straight, 1/4 longer than the anterior margin, the anterior angles obtusely rounded.

Scutellum triangular, equally wide as long; the lateral margins straight; a carina extending along the center to the apex of the scutellum.

Hemelytra not extending to the apical abdominal segment, corium a little more than half as long as the membrane, with two prominent veins; the apical margin broad and weakly emarginate; membrane pale, shiny, with fine, indistinct veins.

♂. Length 2.8-2.9 mm, width of pronotum 0.9-1.0 mm, width of abdomen 1.1 mm.

♀. Length 3.1-3.2 mm, width of pronotum 0.9-1.1 mm, width of abdomen 1.1-1.2 mm.

Japan: Takao-San, Honshu, September 26, 1933 (6 ♂♂, 10 ♀♀; Zhenzhurist).

On the basis of the structure of the head, without parietal processes, the median carina of the pronotum, the fine veins on the hemelytral membrane, and the unusually small size, this species must be separated off into a special subgenus - Mezirella Kirichenko, subgen. nov.

OROËSSA KIRICHENKO, gen. nov.

Syn. Oroëssa Bergr. in litt.

E. Bergroth, who worked up part of the material in the families Aradidae and Brachyrhynchidae of the Ethiopian Region in the Zoological Museum of the Academy of Sciences, established this genus. His description did not appear in print during the lifetime of the author and according to a communication from Dr. H. Lindberg, even the manuscript was not found in E. Bergroth's files. The species Oroëssa asina Bergr. (nomen museale) was described much later by H. Schouteden under the name Mezira lujae Schout. On the basis fof the structure of the pronotum this species is sharply distinguishable from the numerous other species of the genus Mezira and should be separated into a distinct genus, to which the name given in it earlier should be applied.

Type of the genus: Oroëssa lujae (Schout.).

Syn.: Oroëssa asina Bergroth, in litt.; Mezira lujae Schouteden, 1919, Rev. Zool. Afric., VI: 132.

Neuroctenus ater (Yak.).

In my monograph (Kirichenko, 1913) this species was represented only by a collection of V. Dybovskii from the Ussuri River valley at 48° N. lat. At the present time the material in ZIN AN enables one to give a complete picture of the distribution of this species in the Maritime Province.

New localities: Iman Region, July 20, 1931 (2 ♂♂, 3 ♀♀; Sh.); upper source on the Tetyukhe River, July 6, 1915 (1 ♀; R.-K.); Odarka River valley, 25 versts from Evgen'evka, May 19 (1 ♂), June 2 (1 ♀), 5 (1 ♀), 7 (1 ♂), 26 (1 ♀), July 9 (1 ♀), 15 (1 ♂), 1911 (Ch.); Chernigovka, June 7, 1912 (1 ♂; E.); Lunza, 85 km from Voroshilov, June 3, 1915 (♀; E.); Yakovlevka, Kvashuka apiary, June 3, 1926 (1 ♀; D. and E.); Vinogradovka, May 27 (4 ♂♂, 13 ♀♀), 28 (1 ♂), 1929 (K.); Shkotovo, June 7, 1929 (1 ♂; Sh.); Shkotovo Region, June 12, 1930 (1 ♂; Sh.); Suputinka River, Tributary of the Suifun, June 19 (1 ♀), 28 (1 ♀), July 2 (1 ♂), 4 (1, ♂), 1940 (I.), May 15, 1948 (1 ♂; Kur.); middle course of the Suputinka, June 11, 1935, on Tilia amurensis (1 ♂; S.); Kamenka River, tribu- of the Suputinka, June 24, 1928 (6 ♂♂; 4 ♀♀), July 2, 1938 (2 ♀♀; S.); Vladivostok, June 22, 1927 (1 ♂; 2 ♀♀; P.); Maikhinskoe forestry station, May 20, 1929, under bark of Quercus mongolica trunk (1 ♀), June 2, 1929, Quercus mongolica wood shipment (2 ♀♀; Sh.); Kangauz, June 13, 1927 (1 ♂; V.); Tigrovaya, June 26, 1927 (1 ♀; V.).

Neuroctenus macer Kirichenko, sp. n.

♀. Narrow, elongated, the sides almost parallel, coal black except for the pale hemelytral membranes.

Head almost as long as it is wide, including the eyes, 3/4 as long as the pronotum; anterior process extending beyond the apex of the 1st antennal segment, short, widening apically, weakly bifurcate; tubercles bearing the antennae short, extending only to the basal third of the 1st antennal segment, broad, acute; parietal processes in the form of very low teeth, barely projecting beyond the eye orbits. Head surface uniformly colored, coarsely granulate, with longitudinal furrows along the raised crest which extends along the edge of the inner eye orbit, and another pair of furrows delimiting the base of the clypeus. Antennae short, stout; 1st segment somewhat widening from base to apex, weakly curved, not extending to the apex of the anterior cephalic process, falling short of it by 1/3; 2nd equal in length to the 1st, conical, 3 times as broad at the apex as at the

base; 3rd segment with a distinct stalk at the base, slenderer than the 2nd and 1/4 longer, gradually broadening from base to apex; 4th segment a little over half as long as the 3rd, shaped like an elongated bean; first 3 segments covered with blunt tubercles, the apical one bearing slender and rather long setae.

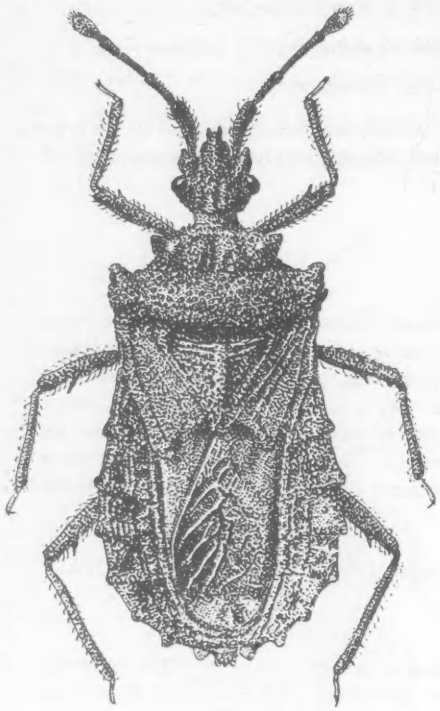

Fig. 6. Artabanus luchti Kir., sp. n., ♀.

Pronotum quadrangular, at most 1/3 wider than long, the anterior and posterior margins broadly and very indistinctly emarginate, the lateral margins rounded, the anterior angles broadly and obtusely rounded. Surface of pronotum coarsely granulate, even-surfaced, with four separated furrows along the raised lateral margins and further in.

Scutellum shorter than the pronotum, its lateral margins strongly raised, straight, the apex rounded, the longitudinal median carina indistinct, effaced.

Hemelytra uniformly colored except for the dirty yellowish white membrane, which, however, has dark brown veins, the outer margins apically bordered with a dark brown stripe.

Connexivum broad, with shallow, elongated depressions and longitudinal carinae along them.

Legs covered with acute tubercles, the tarsi light reddish.

♀. Length 6.3-6.6 mm, width of pronotum 1.9 mm, width of abdomen at the middle 2.1 mm.

Two ♀♀ found by the author at Lazarevko in the Maritime Province (Yakovlevskii Region), May 2, 1929, under the bark of Betula ermani Cham.

It is easily distinguished from Neuroctenus ater (Yak.), the only representative of the genus in the USSR, to which section the newly described species undoubtedly belongs, by the characteristic form of the body, which is narrow, elongated, with almost parallel sides, by the wider and shorter head, by the structure of the antennae, the pattern of the membrane, and other features.

Artabanus luchti Kirichenko, sp. nov. (Fig. 6)

♀. Browish black, more or less becoming reddish, except for the corium of the hemelytra, which is covered above with large granules; body broadly oval, fairly wide. Head and neck longer than the width including the eyes, with short hairs, the anterior process slender, very slightly compressed, slightly inclined down anteriorly, with a deep but narrow excision apically; lateral processes stout, feebly bent, apically acute; posterior ridges on the head surface prominent, merging at the base of the head. Eyes black, shiny, almost smooth. Beak yellowish brown, ending far short of the base of the head, the last two segments equal in length. Bucculae posteriorly broadening into teeth and here enclosing the beak in a groove. Two basal antennal segments with long setae; 1st segment extending beyond the apex of the anterior cephalic process by a little more than half its length, compressed basally, yellowish brown, 1/4 longer than the 2nd; 2nd segment half as long as the 3rd, feebly clavate at the very apex; 3rd segment the longest, with very short, closely set setae, apically very gradually and feebly broadening, 1/3 longer than the 1st segment; 4th segment pear-shaped, abruptly narrowing beyond the middle, the anterior fourth with dense white setae, 1/4 shorter than the 2nd. Pronotum with a feebly rounded posterior margin medially; posterolateral angles feebly extended into lobes directed backwards; lateral margins before the middle deeply and irregularly excised; anterior portion of the pronotum medially with two low ridges and double marginal tubercles along the margin, the posterior portion densely covered with coarse granules; the outer lateral angles displaced forward and slightly outward, broadly excised in a semicircle posteriorly.

Scutellum with transverse rugosities, with a longitudinal carina medially which is of equal height throughout its length. Corium of hemelytron somewhat longer than the scutellum, with some granulation only along the veins; membrane black, shiny, very wide and not shiny at the base, and at the outer margin; no veins. Abdomen somewhat wider than the pronotum; apical angles of segments of connexival margin projecting in the form of large tubercles; surface of connexivum above with large, longitudinal, indistinct ridges. Legs setose; femora of all three pairs with strong teeth before the apex; middle and hind tibiae apically, and tarsi, brownish.

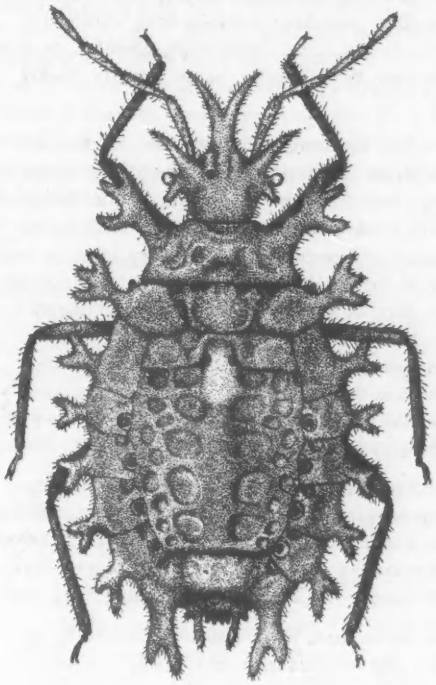

Fig. 7. Pandinocoris milleri Kir., gen. et sp., n., ♀.

Body length 7.3 mm, width of pronotum posteriorly 3.2 mm, width of abdomen 3.7 mm.

Island of Java: Banjoewang (H. Lucht); Sumatra: Loebock Sikaping, 450 m (L. Hundeshagen).

On the basis of the armament of the legs, the femora of all three pairs of which bear spines, this species can be compared only with Artabanus sexspinosus Bergr.

PANDINOCORIS KIRICHENKO, gen. n.

Wingless. Head longer than its width including the eyes. Its anterior process longer than the rest of the head, from the base to the middle with straight sides, feebly widening only toward the apex; distally the process is drawn out into two slender, diverging, prong-like points; similar points, but longer and more slender, feebly curved, placed before the eyes and extending to the 2/3 point of the 1st antennal segment. Eyes small, globular, projecting. Postocular processes broad, turned back somewhat, barely extending beyond the outer edge of the eye; the head behind them narrowed. Beak extending to the base of the head. Antennae not stout, equal in length to the head and pronotum combined; 1st segment not quite reaching the apex of the prongs of the anterior cephalic process, stouter than the 2nd or 3rd; 2nd segment almost cylindrical, more slender than the apical half only toward the base, 1/3 shorter than the 1st; 3rd segment cylindrical, somewhat slenderer than the 2nd and 1/3 longer; 4th 3/4 as long as the third, broadening towards the apex in the form of an elongate club, provided with very fine setae.

Pronotum as long as the head, anteriorly with the margins oblique; trifurcate processes growing out from the anterior angles of the pronotum and the posterior angles of the mesonotum; pronotum and metanotum equal in length.

Scutellum short, broadly rounded, somewhat wider than long. Abdomen broadly oval, feebly widening posteriorly, the lateral margins rounded, each segment bearing bifurcate outgrowths; these are shorter than the projections of the pronotum, with a short and broad base; the lobes of the bifurcate processes are equal in length and form except for those of the apical segment, in which the posterior lobe is considerably longer than the anterior. Genital segment terminating in two long, slender, cercus-like outgrowths.

The entire body with its projecting portions, the antennae, and legs covered with short setae.

Type of the genus: Pandinocoris milleri Kirichenko, sp. n.

Pandinocoris milleri Kirichenko, sp. n. (Fig. 7)

Black fading into brown, mat, densely provided with erect setae which are equally long on the antennae,

processes of the head, forked processes of the abdomen and femora. The metanotum has a smooth, rust colored, longitudinally oriented section.

♀. Length 18 mm, width of pronotum 6 mm, width of abdomen medially 9 mm.

Madagascar: ♀ - Tanovana, 630 m, 1934 (G. Olsuf'ev).

CIMICOMANES KIRICHENKO, gen. nov.

Wingless, strongly broadened posteriorly. Head longer than its width including the eyes; the anterior process apically divided; the points broad, acute, outwardly diverging; preocular processes long, outwardly bent, extending to the halfway point of the 1st antennal segment, apically acute. Eyes small, globular, prominent. Postocular processes extending beyond the outer orbits of the eyes, broad basally, acute apically, feebly bent or almost straight; behind them the head gradually narrows.

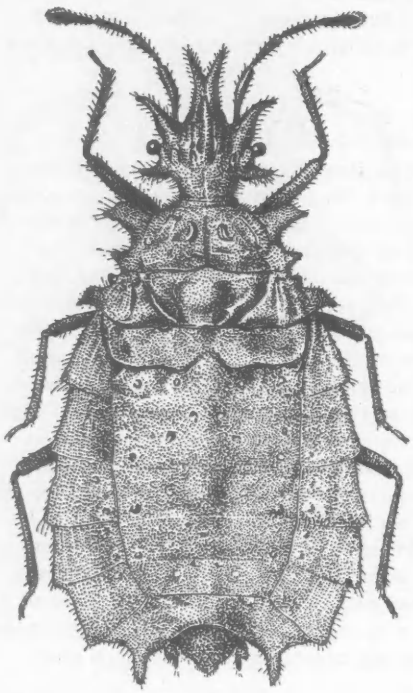

Fig. 8. Cimicomanes usingeri Kir., gen. et sp. n., ♂.

Pro- and mesonotum combined shorter than the head; pronotum anteriorly deeply emarginate, laterally bearing two projecting outgrowths, the anterior being the larger, with a broad base and ending in a blunt tooth, which is displaced posteriorly, at the very apex; a deep emargination behind the anterior process; posterior process in the form of a small, blunt tooth. Metanotum a little over half as long as the pronotum, the margins bearing processes which are obliquely cut at the apex and longer than the second pair of pronotal processes and shorter than the first pair. Scutellum twice as wide as long, broadly rounded at the apex.

Abdomen with the posterior margins of the segments projecting; their lateral margins straight, the anteapical one emarginate, the apical one deeply emarginate, terminating in two teeth. Genital segment laterally with cercus-like outgrowths extending to its apex.

The entire head, thorax, abdomen laterally, antennae, and legs covered with fairly long, fine setae.

Type of the genus: Cimicomanes usingeri Kirichenko, sp. nov.

On the basis of the head structure this genus is very close to the genus Pandinocoris Kir., but it is easily distinguishable by the structure of the abdomen, which does not bear characteristic outgrowths of a bifurcate type, and by other characters.

Cimicomanes usingeri Kirichenko, sp. nov. (Fig. 8)

♂. Rusty brown, feebly shining. Head processes, antennae, lateral margins of the pronotal processes, segments of the abdominal margin, and femora provided with long, slender setae.

Length 11.5 mm, width of pronotum posteriorly 4 mm, width of abdomen 6 mm.

Madagascar: Anamalasotra near Perinet, November 1930 (♂; G. Olsuf'ev).

Cimicomanes alter Kirichenko, sp. nov.

Distinguishable from C. usingeri, sp. n., by the body less broadened posteriorly. Black, mat. Antennae shorter and stouter.

Length 10.8-11.8 mm, width of pronotum 4-4.1 mm, width of abdomen 5-5.4 mm.

Madagascar: Perinet, 850 m, December 1932 (♂), February 22, 1935 (♂; G. Olsuf'ev).

EVALDIUS KIRICHENKO, gen. nov.

Body thin, almost leaf-like, broadening posteriorly. Head quadrangular, longer than its width including the eyes; anterior process short, barely extending beyond the narrowed portion of the 1st antennal segment, deeply excised apically; tubercles bearing the antennae in the form of sharp vertical plates strongly toothed along the margin; parietal processes substituted along the postocular portion of the head by lamellate borders provided with large blunt teeth; head surface strongly tuberculate, with a deep median furrow coming out of the base of the clypeus and two lateral V-shaped grooves. Antennae long and slender; 1st segment the stoutest, almost 3 times as long as the 2nd, cylindrical except for the narrowed base, feebly bent, provided with tubercles bearing short setae; 2nd segment the shortest, almost cylindrical; the 3rd feebly capitate only at the very apex, equal in length to the head, pronotum, and scutellum combined; its tubercles very small, terminating in very short setae; 4th segment almost twice as long as the 2nd, slender for the first third of its length, then spindle-shaped, broadened, provided with long setae.

Pronotum trapezoid, narrowed anteriorly; the anterior margin deeply emarginate, the lateral margins dentate and turned up, sinuate in outline, anteriorly feebly emarginate, then rounded out, then once again feebly emarginate, rounded after the middle; anterolateral angles displaced forward, with obliquely truncate apices. Surface with alveolar depressions with thickened edges. Scutellum triangular, its lateral margins feebly emarginate before the apex, carinate; a dull carina extends down the center of the scutellum.

Hemelytra semitransparent; lateral margins of the widened portion of the corium straight, broadly reflexed; veins of membrane thickened but effaced, forming an irregular network of sinuate curves.

Lateral margins of the connexival segments, except for the third, emarginate at the basal half, widened and rounded at the apical; thier apical lateral angles broadly rounded, projecting, those of the eigth segment broadly triangular, projecting more than 3/4 of the length of the lateral lobes of segment IX.

Type of the genus: Evaldius annulipes Kirichenko, sp. nov.

On the basis of various characters – the very long and slender 3rd antennal segment, the long 1st segment clothed with coarse setae and extending far beyond the apex of the anterior cephalic process, the structure of the connexivum – this genus is closely related to the Neotropical genus Notoplocoris Usinger, 1941; it is easily distinguished from the latter by the presence of fully developed wings, the quadrangular structure of the head, its anterior process which barely extends to the apex of the stalked portion of the 1st antennal segment, the jugal processes equal in length to the clypeus, and other characters. A distant relationship may be observed between the described genus and Miorrhynchus Champ.

A comparison of Evaldius, gen. nov., with Notoplocoris Usinger – the former with winged individuals, the latter with wingless – compels one to arrive at the conclusion that it is artificial to separate genera having lost their wings, on the basis of this character, into a distinct subfamily Chelonocorinae.

The structure of the antennae, except for their apical segment, and other characters place the described genus close to the wingless Neotropical genus Notoplocoris Using., but in addition to the fact that it is winged it may be easily distinguished by the structure of the head and cannot be united with the latter.

Evaldius annulipes Kirichenko, sp. nov. (Fig. 9)

Light chestnut colored; a large rounded spot at the apex of the scutellum and some small spots at the lateral angles of its anterior margin black. The anterior lateral angles of the connexival segments in the ♀ with black areas in the form of longitudinal blotches; in the ♂ the connexivum is uniform in color. Femora with broad dark brown basal and apical areas, with a median lighter interval which considerably exceeds in length the basal and apical brown rings of the tibiae.

♂. Length 6.2 mm, width of pronotum posteriorly 1.3 mm, width of abdomen 2.8 mm.

♀. Length 6.8 mm, width of pronotum posteriorly 2.2 mm, width of abdomen 3.4 mm.

Madagascar: Anamalasotra, Perinet, November 1930 (♂, ♀; G. Olsuf'ev).

BERGROTHISTA KIRICHENKO, gen. nov.

Body thin, almost leaf-like, strongly broadened posteriorly; lateral margins of the abdominal segments straight.

Head quadrangular, 1/3 shorter than the pronotum and barely longer than the scutellum; its anterior process projecting beyond the narrowed portion of the 1st antennal segment, shaped like a short, stout prominence, anteriorly narrowing and apically rounded; tubercles bearing the antennae in the form of vertical plates apically moderately acute and slightly bent inward; parietal processes in the form of crests bordering the posterolateral margins of the head. Antennae placed far forward, slender except for the first segment; 1st segment very stout, elongate, bean-shaped, covered with tubercles bearing short setae at their apex; 2nd segment 3/4 as long as the 1st and 1/4 to 1/3 its width, almost cylindrical, feebly narrowing towards the base; 3rd segment long and slender, capitate only at the very apex, equal in length to the head and the pronotum combined; 4th segment elongated, bean-shaped, the basal ahalf with a slender stem, the apical half thickened.

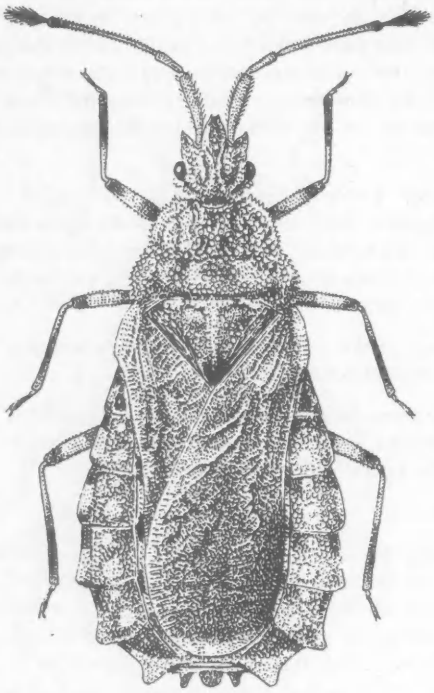

Fig. 9. Evaldius annulipes Kir., gen et sp. n., ♀.

Pronotum trapezoid, equal in length and width; its anterior margin emarginate, the posterior straight along the scutellum, with projecting prominences at the sides of the latter; lateral margins turned upwards, broadly but indistinctly curved, obtusely dentate. Surface of pronotum densely covered with close-set areolar tubercles. Scutellum triangular, somewhat longer than wide, a little more than half as long as the pronotum; its lateral margins straight, carinate, the apex acute, basally with two lateral and two median plates bearing areoles.

Hemelytra semitransparent, the lateral margins of the corium cut off straight at the widened portion, reflexed upward, the veins of the corium strongly convex.

Lateral margins of the connexival segments straight, that of segment VI widely and feebly curved, that of segment VIII broadly emarginate.

Type of the genus: Bergrothista villiersi, sp. nov.

Very closely related to Evaldius, gen. nov., but easily distinguished from it on the basis of the antennal structure, the first antennal segment being short and strongly expanded, and the deeply emarginate anterior pronotal margin.

Bergrothista villiersi Kirichenko, sp. nov. (Fig. 10)

Light chestnut colored with black areas on the outer and inner angles of the anterior margins of the abdominal segments; apex of hemelytral membrane with a large, dark, triangular area which widens anteriorly; antennae and legs reddish brown. 2nd antennal segment somewhat broadening apically, almost cylindrical, 2/3 as long as the 1st.

Length 5.6 mm, width of pronotum posteriorly 1.8 mm, width of abdomen 2.6 mm.

Madagascar: Perinet, March 14, 1935 (♀; G. Olsuf'ev).

Bergrothista nigricornis Kirtchenko, sp. nov.

Differs from B. villiersi, sp. n., by its black antennae and legs, the shorter and stouter 2nd segment and considerably longer 3rd and 4th segment of the antennae. Lateral margins of the pronotum rounded. Hemelytral membrane uniformly colored, devoid of a black area apically.

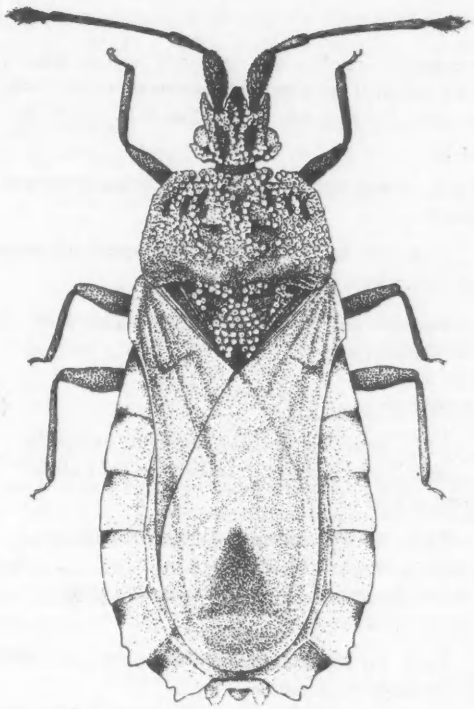

Fig. 10. Bergrothista villiersi Kir., gen. et sp. n. ♀.

Length 5.6 mm, width of pronotum 1.6 mm, width of abdomen 2.5 mm.

Madagascar: Ambohipanja near Sahambeky (♂; Catala).

COLOBORHINOMORPHA KIRICHENKO, gen. nov.

Body thin, leaf-like, posteriorly broadened, with almost straight (♂) or feebly curved (♀) lateral abdominal margins. Head width, including the eyes, greater than its length; its anterior process broad and short, extending to 1/2 or 3/4 of the length of the 1st antennal segment; jugae extending forward far beyond the apex of the clypeus and not coming in contact here, such that the anterior process is deeply divided apically; tubercles bearing the antennae broad, obliquely placed, in the form of plates, barely extending beyound the stalk of the 1st antennal segment; parietal processes short and broad, barely extending beyond the outer orbit of the eyes, feebly curved back. Surface of head with a carinately raised clypeus with two deep grooves along its sides. Antennae slender; 1st segment extending for half its length or more beyond the anterior cephalic process, its posterior third strongly narrowed, forming a more or less elongate stalk; 2nd segment 1/3 longer than the 1st, capitate apically; 3rd segment the longest, equal in length to the head or longer, very slender, slightly thickened only at the extreme apex; 4th segment slender from base to middle, then bean-shaped, with long setae.

Length or pronotum exceeding the width at the posterior half by only 1/4; its lateral margins broadly but not deeply emarginate; anterior margin straight; posterior margin convex before the scutellum; anterolateral angles shaped like broad lobes, broadly rounded apically, turned upward. Scutellum transverse, the apex broadly rounded, excavated, and with a dull carina.

Corium of hemelytra very small, shaped like a skewed trapezoid, coriaceous; its lateral margins almost straight, projecting beyond the margin of abdominal segment III; membrane very large, completely transparent. Connexivum broad, densely covered with punctiform, minute, shiny tubercles.

Type of the genus: Coloborhinomorpha chinai Kirichenko, sp. nov.

Closely allied to the Neotropical genus Coloborhinus Bergr., from which it differs by having a short anterior cephalic process, very large, not lamellate jugal plates, and a rounded apex to the scutellum.

Coloborhinomorpha chinai Kirichenko, sp. nov (Fig. 11)

Uniformly colored, pale chestnut; apex of scutellum with a large black spot; abdominal segment with

three shiny areas, one at the inner angle of the anterior margin, two obliquely situated from the inner angle of the posterior margin to the middle of the lateral margin. Lateral margin of the connexivum straight; hindangles of the segments rounded, barely projecting.

♂. Length 4.9 mm, width of pronotum posteriorly 1.5 mm, width of the abdomen 2.3 mm.

♀. Length 5.8 mm, width of the pronotum posteriorly 2.3 mm, width of abdomen 2.8 mm.

Madagascar: Perinet, February 23 (♂), 28 (♀), 1935 (G. Olsuf'ev).

Coloborhinomorpha parva Kirichenko, sp. n.

Easily distinguished from the preceding species by its considerably smaller size. Anterior cephalic process broadly divided apically, extending beyond the middle of the 1st antennal segment; 1st antennal segment considerably shorter and stouter; 2nd more thickened towards the apex; 3rd and 4th shorter than in C. chinai, sp. n.

Scutellum apically fuscous but without a distinct black spot. Posterolateral angles of the connexivum projecting and obtuse. Pronotum shorter and more deeply emarginate.

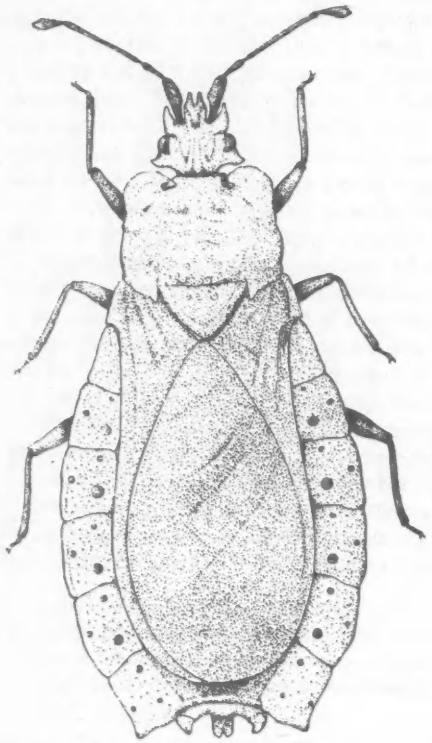

Fig. 11. Coloborhinomorpha chinai Kir., gen. et. sp. n., ♀.

♂. Length 4.1 mm, width of pronotum posteriorly 1.3 mm, width of abdomen 1.8 mm.

Madagascar: Perinet, 950 m, December 1932 (♂; G. Olsuf'ev).

Key to the Genera

1 (4). Entire 1st antennal segment, except for the extreme base, projecting beyond the apex of the anterior process of the head.

2 (3). 1st antennal segment long and slender, 2½ times as long as the 2nd . . . . . Evaldius, gen, n. (type of the genus Evaldius annulipes, sp.n.).

3 (2). 1st antennal segment spindle-shaped, stout, only 1/3 longer than the 2nd . . . . . Bergrothista, gen n. (type of the genus Bergrothista villiersi, sp. n.).

4 (1). Half or less of the 1st antennal segment projecting beyond the sapex of the anterior process of the head. Coloborhinomorpha, gen. n. (type of the genus Coloborhinomorpha chinai, sp. n.).

Aneurus laevis F.

Bryansk, on the Bolva River, July 4, 1925, on the bark of the rotten oak stump (1 ♀; V. Stark); Fedvar, Nerubaevskii Forest on the River Tyasmin, March 24, 1923 (4 ♂♂, 6 ♀♀; A. Kirichenko); Benderi, XXIV, May 6, 1907 (1 ♂; E. Yatsentkovskii).

Crimea: Eni-Sala, April 20, 1907 (1 ♂, 3 ♀♀, larv.; K. Khristoforov); Kizil-Khoba (1 ♀; Pliginskii); Dzhalman, September, 1910 (3 ♀♀; G. Kakhovskii); Alushta, Ak-Chokrak, July 5, 1911 (1 ♀; A. D'yakonov); Korbekly, August 6, 1906 (1 ♂, 1 ♀; K. Khristoforov), August 3, 1907 (1 ♂, 2 ♀♀, larv.; A. Kirichenko); Chatry-Dag, April 28 (1 ♀), June 18 (2 ♂♂, 3 ♀♀), 1907 (A. Kirichenko); Taushan-Bazar, June 10 (1 ♀), 23 (1 ♀), 26 (4 ♂♂, 13 ♀♀), July 9 (3 ♂♂, 1 ♀), 1907 (V. Pliginskii), June 4, 1907 (3 ♂♂, 5 ♀♀; A. Kirichenko); Degermenkoi,

June 12, 1907 (1 ♀; V. Pliginskii); Karadag by Skeli Rd., May 18, 1921 (1 ♂, 2 ♀♀; V. Kizeritskii); Mekenzievy Mts., September 19, 1940 (11 ♂♂, 3 ♀♀, larv.; V. Parfent'ev); southern shore of Crimea, June 1903 (1 ♀; E. Yatsentkovskii).

Caucasus: Novorossiisk (1 ♂, 3 larv.; A. Stark); Gelendzhik, June 17, 1948 (1 ♂, 3 ♀♀; O. Krizhanovskii); NW Caucasus (1 larv.; A. Stark); Sochi (2 ♂♂, 4 ♀♀; A. Stark); Krasnaya Polyana, 1907 (A. Kirichenko); Sukhumi, March 10-13, 1932 (1 ♀; Stepanov), June 18, 1932 (1 ♀; V. Belizin); Azhara, July 30, 1905 (2 ♀♀; Kalishevskii); Maikop, July 28, 1932 (1 ♂, 2 ♀♀; K. Arnol'di); Ayuk R., in the beech forest zone, May 12, 1928 (5 ♂♂, 7 ♀♀; E. Stepanov); Goryachii Klyuch, May 14, 1928 (5 ♂♂, 2 ♀♀; E. Stepanov); Stepanovan, July 26, 1920 (1 ♂, 1 ♀; A. Shelkovnikov); Zakataly, July 29, 1928 (2 ♀♀; Bocharnikov); El'dar, September 21, 1910 (1 ♀; Mlokosevich); Tsakhkadzor, July 1-3, 1910 (1 ♀), July 1-10 (1 ♂), June 15-25 (1 ♂, 1 ♀), 1911 (D. Malyzhenko), Lirik, May 12, 1909 (4 ♂♂, 6 ♀♀; A. Kirichenko); Paleton, July 20, 1932 (1 ♂; D. Znoiko); Torady, July 21, 1932 (12 ♂♂, 22 ♀♀, 4 larv.; D. Znoiko); Alazatin-Podgornoe, August 8, 1929 (4 ♀♀, 6 ♂♂; K. Arnol'di); Bilyasar, June 6 (1 ♂, 2 ♀♀), 7 (2 ♂♂, 5 ♀♀), 1936 (K. Arnol'di).

Iran: Gorgan (2 ♂♂), Kyshtybi, April 7-8, 1916 (1 ♂; B. Il'in).

Aneurus avenius Duf.

Belorussia, Mikhnovichi, May 1907 (1 ♀; V. Seslavin); Leningrad Region: Mednaya on the Neva, June 21, 1924 (1 ♀; V. Barovskii); Fan-der-Flit station, Luzha Region, June 22, 1925 (1 ♀; A. Vul'f); right bank of the Tosna, May 20, 1921 (1 ♂; V. Fridolin), May 8, 1921, under bark of birch infested with Scolytus retzeburgi (1 ♂, 1 ♀), May 17, 1923 (1 ♂), birch stump in garden (D. Pomerantsev); Koshelevskaya wood plot, Gomel' Region, Bryansk, May 25, 1907 (1 ♂; Vinogradov-Nikitin); Staraya Pustyn', Gor'kii Region, September 3, 1939 (20 ♂♂, 40 ♀♀, 5 larv.; Kirichenko); Kazan', May 6 (1 ♀), 26 (3 ♀♀), (1 ♀; E. Eversman); Ternovka, Salval' forestry station, May 5, 1952 (1 ♂; V. Stark); Kirovograd, April 20, 1906 (1 ♀; K. Yatsentkovskii); Fedvar, Nerubaevskii Forest on the Tyasmin, August 24, 1923 (6 ♀♀), under bark of oak (A. Kirichenko); Gornaya, May 8, 1911 (1 ♀; V. Kizeritskii); Crimea: Chumakary, April 30, 1903 (1 ♀; K. Khristoforov); Babugan, June 15-16, 1927 (2 ♂♂; F. Luk'yanovich); "Kuban Region", July 25, 1891 (1 ♂; V. Vorob'ev); Khosta, (2 ♀♀; A. Sabler); Krasnodar, March 29 (2 ♂♂, 1 ♀), April 25 (1 ♂, 2 ♀♀), 1925 (E. Stepanov); Maikop, May 4, 1911 (1 ♀; Kh. Shaposhnikov); Guzeripl', September 11, 1929 (4 ♂♂, 16 ♀♀; P. Slashchevskii); Lagodekhi, May 9 (1 ♀; Mlokosevich); Tsakhkadzar, Armenia (1 ♀; Malyuzhenko); W. Kazakhstan: Belye Klyuchi, Mustaev Region, August 1, 1949, under bark of oak (2 ♂♂, 1 ♀; K. Romadina); Siberia: Barnaul, May 27, 1920 (1 ♀; E. Rodd); Mazhorka, Minusinsk, June 19, 1925 (1 ♀; M. Serebrennikov); Padun, upper Angara, 1867 (1 ♀; A. Chekanovskii). Khabarov Region: Nekrasovka, SW of Khabarovsk, July 1930 (1 ♂, 1 ♀; Pr.); Maritime Region: upper Ioldzykhe, Beregovaya apiary, June 25, 1928 (2 ♂♂, 5 ♀♀; A. Formozov); middle Malaza, August 7, 1931 (2 ♂♂; Kur.); middle Suputinka, 1937 (1 ♀; Kur.); Krivoi Klyuch, Tributary of the Suputinka, June 10, 1938 (1 ♀; S.), July 11, 1932 (1 ♀; Rikht.); forestry station along the Maikhé, June 13, 1929 (1 ♂, 1 ♀; Sh.); Kangauz, July 5, 1928 (4 ♂♂, 5 ♀♀, larv.; Rost.); Tigrovaya, July 10, 1928 (3 ♂♂, 8 ♀♀; Rost.).

Aneurus macrotylus Yak.

Belong to the A. avenius Duf. group, but is easily distinguished from it by the strongly widened body posteriorly, the deeply emarginate lateral margins of the pronotum, the shorter and wider scutellum, the yellowish white hemelytra, except for a rusty brown at the base of the angles of the corium; the membrane is pale, feebly wrinkled. The 2nd antennal segment is longer, almost cylindrical. The hind margin of the genital segment of the female is straight.

The quite unexpected finding of this Far Eastern species in the semideserts of the Transvolga is evidently connected with the transfer of trees for afforestation.

Urda, western Kazakhstan region May 14-28, 1936 (1 ♀; A. I. Vorontsov). Khekhtsyr Ridge, September 1930 (1 ♂; Pr.); S. shore of the Tatar Strait, 46° 30' N. lat., Sikhoté-Alin', May 19, 1915 (1 ♂; N. Krylov). Samarga River, August 10, 1925 (1 ♀), Sudzukhé R., Primorskii Preserve, July 14, 1946 (♀), August 18, 1948 (4 ♂♂, 3 ♀♀; Sharov); Chernigovka, June 30 (1 ♂), July 14, 1913 (1♀; E.). Yakovlevka, Lazarevskaya Rd., August 25, 1926 (6 ♂♂, 10 ♀♀; D. and F.); Vinogradovka, May 21 (2 ♂♂, 4 ♀♀), June 7 (1 ♂, 1♀), July 9 (2 ♂♂, 1 ♀), August 9 (1 ♂), 1929 (K.); Suifun Region, May 26, 1930 (1 ♀; Sh.) Shkotovo, June 21, 1930 (1 ♂

in flight; Sh.); Shkotovo Region, July 28, 1931 (3 ♂♂, 1 ♀; M.); upper Suputinka, June 2, 1935 (3 ♀♀; Kur.); Suputinka R., July 28 (12 ♂♂, 37 ♀♀, under bark of Jugulans mandshurica), July 28 (1 ♂, 10 ♀♀, 10 ♀♀, larvae. under bark of Acer mandshurica), August 2 (1 ♂, 1♀), July 30-31 (2 ♂♂, 2 ♀♀, larvae on Populus), July 28 (3 ♂♂, 17 ♀♀, 6 larvae on Betula costata), 1940 (I.); Krivoi Klyuch, July 7, 1937 (2 ♂♂, 1 ♀; Rikht.); Beloborodovskii spring, source of the Sitsa, September 17, 1945 (1 ♀; Kur.); Vladivostok, Zolotoi Rog Bay, May 28, 1910 (1 ♂, 1 ♀; Ch.), same on linden (2 ♀♀, without data; Ch.); Vladivostok, Shamor R. valley, June 21, 1925 (7 ♂♂; Rost.); 19 versts from Vladivostok, June 7, 1935 (2 ♂♂, 2 ♀♀; Vas.); Sedanka, September 18, 1932 (1 ♂; Rys.); Russkii Island, June 24-July 10, 1928 (2 ♂♂, 3 ♀♀; Pr.); Askol'd Isl., 1918 (1 ♀; Pr.); forestry station along the Maikhé, July 24, 1931, on Fomes fungi (1 ♂; M.); Tigrovaya, June 26, 1928 (2 ♀♀; Rost.), August 5-9, 1926 (1 ♂; Kuzn.), June 12, 1927 (1 ♀; Sht.).

Iturup Island, Juriles, June 30, 1954 (3 ♀♀, larva; Violovich).

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* In Russian.

SCORPION FLIES (MECOPTERA) OF THE USSR FAUNA

III.* FAMILY BITTACIDAE

O. M. Martynova

The family Bittacidae comprises 7 genera and 71 species, 62 of which belong to the genus Bittacus.

This family is distributed throughout the world, but largely predominates in the southern hemisphere. In Europe we find only three species of the genus Bittacus, two of them from the Caucasus and Crimea.

In Asia too, there occurs only the genus Bittacus, with 12 species; of these, only 1 species, B. sinensis, extends into the palaearctic part of Asia (Maritime Territory).

Species of the genus Bittacus are slow, weak fliers and never capture their food in flight. Usually they rest on the underside of leaves and lie in wait for hours for their prey. Unwary insects which approach Bittacus are seized with a swift thrust of its legs. The long and mobile claw curves backwards with the entire tarsus and helps to grip the victim. Still hanging by its forelegs on the leaf or branch, Bittacus holds its prey with its middle and hindlegs, then by slow movements draws its victim toward its beak-like mouth, which it thrusts between the segments of the abdomen or between the neck and head, and sucks the insect dry. Like the Panorpidae, they can also feed on dead insects. The eggs are laid in the soil in autumn, in a small batch or singly. In spring, there emerges a larva which does not live in the soil, but on its surface, among rotting leaves. The larva feeds on dead insects, rotting plant detritus, and even on soil. Before pupation the larva makes a little chamber in the soil. The biology of the Bittacidae inhabiting the USSR has not yet been studied.

Among the Bittacidae there is one wingless form, Apterobittacus apterus McL., described from California. A. apterus is just as successful in capturing its prey as the winged forms.

The ancestors of Bittacidae can be traced to the Permian period. There is a Permian genus Robinjohnia O. Mart., 1948, in which the wing is of the bittacoid type; this form differs comparatively slightly from the Mesozoic family Neorthophlebiidae, which was apparently derived from forms similar to Robinjohnia. The finding of Neorthophlebiidae, the undoubted ancestors of the contemporary Bittacidae, in almost all the Mesozoic insect localities permits the conjecture that in the Mesozoic era the ancestors of Bittacidae were much more widely distributed than their progeny now. The family Bittacidae is known from the Tertiary period. The Eocene species Palaeobittacus eocenicus Carp., 1923, described from Colarado (Green River) is close to the contemporary Bittacus but differs in the rather more archaic venation (5-branched M and cross vein between base of Rs and M). In the Oligocene Electrobittacus antiquus (Pict.) Carp. from Baltic amber the wing venation does not differ in any way from that of the contemporary Bittacus, and only the beak (rostrum) in the Oligocene form is a little shorter.** It is difficult to speak of its affinity with the contemporary B. reticulatus Heer, 1894, since it is described from a very small fragment of wing.

At the present time the Bittacidae in the USSR do not occur north of southern Ukraine; they inhabit the Crimea, Caucasus and the Maritime Territory.

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*I. Fam. Boreidae (Tr. Zoolog. inst. AN SSSR 15, 1954); II. Fam. Panorpidae (Éntom. obozr. 3, 721-747, 1957).

**B. validus Hagen can hardly be assigned to the Bittacidae, although it probably belongs to the Mecoptera.

Key to Species

1 (2). Sc of forewing terminates before the first fork of Rs. – Central and southern Europe . . . . . B. italicus Müll.

2 (1). Sc of forewing terminates level with first fork of Rs.

3 (4). Wing large, 23 mm long, yellow, with four round brown spots and a few diffuse cross veins – southern Maritime Territory, China . . . . B. sinensis Walk.

4 (3). Wing much smaller, 16 mm long. No colored markings on wing. Caucasus, central and western Europe . . . . . P. hageni Br.

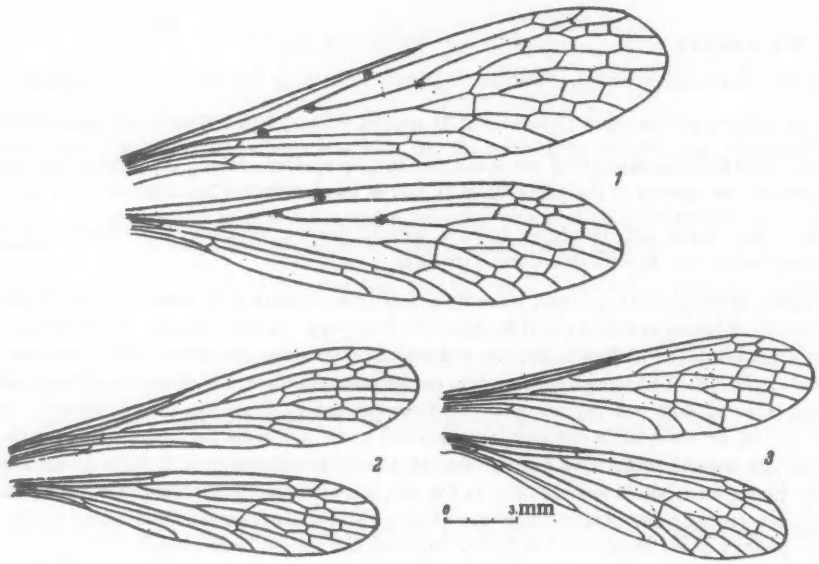


Fig. 1-3. Wings. 1) Bittacus sinensis Walk.; 2) B. italicus Müll.; 3) B. hageni Br.

1. Bittacus italicus Müller, 1766 (Fig. 2,5)

Panorpa tipularia Fabricius, 1775, Syst. Ento.: 314, Bittacus tipularius Latreille, 1805, Hist. Natur. Crust. et Ins., VIII: 20; Panorpa tipuloides Schrank, 1776, Beitr. z. Naturgesch.: 82.

Wings (Fig. 2) unicolorous, without markings. Sc of forewing reaching only to middle of stem of Rs. Rs commences at beginning of second third of wing length. First fork of Rs situated at center of wing length. CuA strong, long terminating without an abrupt bend toward hindmargin, but approaching it gradually. CuP, where it meets hindmargin, forming a small notch (as if pulling in the hindmargin a little). A_1 long, reaching almost to fork of Rs. A_2 short, united at apex to A_1 by a cross vein.

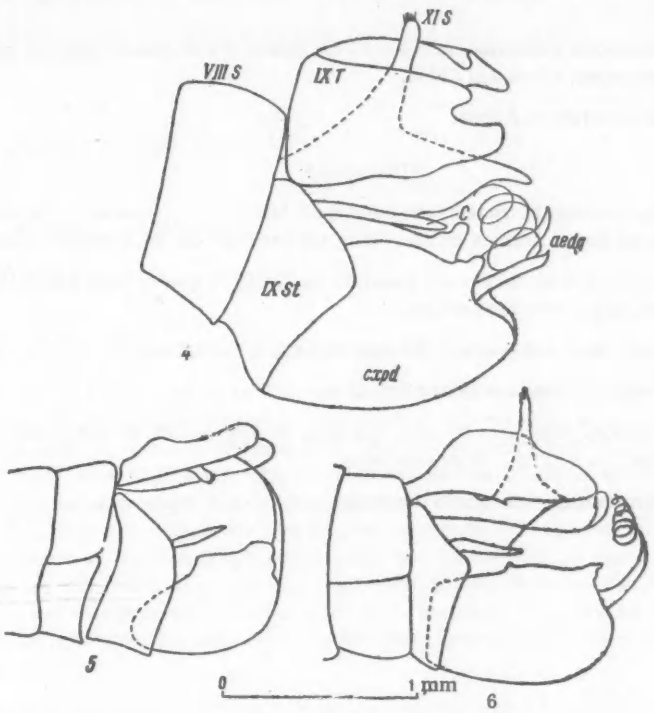
End of abdomen ♂. Tergite IX in lateral aspect (Fig. 5) with a gibbous protuberance on dorsal margin; apex of tergite round; on ventral side it forms a straight line, in the center of which there is finger-like process directed downwards and slightly inwards, with short black spines on the rounded end. Sternite IX with rounded apical margin. Segment X not visible; cerci short. Gonopod short, small. Aedeagus needle-like, bent slightly inwards.

The collection of the Zoological Institute AN SSSR contains 29 specimens from the Caucasus, 6 specimens from the Crimea, 2 specimens from the Kazhi-Tugai natural region (Urals) and 11 specimens from the Ukraine (Gadyach, Poltava region). Recorded from southern and central Europe.

The flight extends from June to early October. It is found most frequently in July and August.

2. Bittacus hageni Brauer, 1860 (Fig. 3, 6)

Wings (Fig. 3) differing little from those of B. italicus except in size – their length is 15-16 mm. Sc of forewing longer and terminating on the costa level with the fork of Rs. CuA of forewing bending sharply distally before fusion with the hindmargin of wing, and forming a small dent. A_1 considerably shorter than in preceding species – terminating level with base of Rs. On the wing there are small, barely distinguishable, pale spots – at divergence of M from CuA, at base and fork of Rs, and close to end of Cu P.



Figs. 4-6. Abdominal segments VIII and IX of ♂ and their appendages. 4) Bittacus sinensis Walk.; 5) B. italicus Müll.; 6) B. hageni Br. IX T – ninth tergite; IX St – ninth sternite; XI S – eleventh segment; cxpd – coxopodite; c – cerci; aedg – aedeagus.

End of abdomen ♂. Tergite IX (Fig. 6) with rounded distal ends curved inwards, invested densely with sessile spines along margin. Dorsal margin (lateral aspect) without gibbous projection as in B. italicus, but possessing a small protuberance invested with short spines in the center of its side; a small acute projection present on ventral side. Apical line of sternite IX forming an angle. Gonocoxite large and stout, with a small backward-pointing projection on top of distal margin. Aedeagus stouter at base than in B. italicus, shorter and forming a spiral filament at the end. Cerci longer than in B. italicus. Acute end of segment XI projecting above tergite IX.

In the Zoological Institute collection there is 1 ♂ with the label "Paraboch, Kizlyar district, Tersk region, July 16, 1927. E. N. Kirichenko" and 1 ♂ with no label. The species is recorded from central and western Europe.

3. Bittacus sinensis Walker, 1853 (Fig. 1, 4)

Diplostigma sinensis Navas, 1908, Mem. Real. Acad. Cienc. Art. Barcelona: 413; Bittacus quaternipunctatus Enderlein, 1910, Zool. Anz. XXXV, 12/13: 397; Bittacus strategus Navas, 1913: 442.

Wings large (Fig. 1), 22-23 mm long. Sc of forewing long, terminating a little beyond fork of Rs. A long, reaching level of fork of Rs. Four round brown spots in the following positions – at divergence of M from CuA, at base and fork of Rs, and on the subcostal cross vein. In addition, the wing membrane is of a pale brownish color over the cross veins associated with the branches of Rs, and on the site of the faceted organs.

End of abdomen ♂ (Fig. 4). Tergite IX with incision on distal margin, thus forming two lobes – a short upper and long lower. The upper line of sternite IX forming a less obtuse angel than in B. hageni, but with a more rounded apex. Gonocoxite with backward-directed projection on distal margin. Aedeagus short with spiral line at tip. Cerci long, reaching almost to projection on gonocoxite. Segment XI with rounded apex, projecting above tergite IX.

In the Zoological Institute collection there are 11 specimens of this species from the Maritime Territory. It has been recorded from Japan, Korea and China.

The flight extends from July to August.

SUMMARY

A study of the wing venation in contemporary and fossil Mecoptera enables us to establish the origin of the family Bittacidae as the Lower Tertiary period. They are derived from the Mesozoic Neorthophlebiidae.

At present only 3 species of Bittacidae are known in the USSR: 2 species from the southern Ukraine, the Crimea and the Caucasus, and 1 from the Far East.

1 (2). Sc of forewing short, not reaching the base of the first fork of Rs. Europe . . . . B.italicus Müll.

2 (1). Sc of forewing reaching base of first fork of Rs.

3 (4). Length of forewing more than 23 mm; markings on wing in form of 4 spots and cross veins diffuse Maritime Territory, China . . . . . B. sinensis Walk.

4 (3). Forewing 16 mm long; no colored markings. Caucasus, Europe . . . . . B. hageni Br.

A SYSTEMATIC REVIEW OF THE SPECIES OF THE GENUS ELATER L. (COLEOPTERA, ELATERIDAE) OF THE USSR. II*

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GENUS ELATER L.

Subgenus Ectamenogenus Buyss.

First Group of Species

ELATER FULVUS RTT.

Reitter, 1891, Wiener Entom. Zeit., X: 234; Reitter, 1918, 37: 104.**

Unicolorous reddish brown, dorsum and venter with reddish pubescence. Head coarsely punctate, interspaces between punctures smaller than punctures. 2nd antennal segment as broad as long. 3rd conical, a little longer than 2nd and about two thirds of length of 4th; segments, beginning from 4th, have a length 1½-2 times greater than their width at apex. Pronotum slightly transverse, in female a little wider than elytra, parallel-sided from base to center, narrowing roundly anterad of center; additional carinae on hindangles of pronotum very distinct; basal surface and median line absent; puncturation on disk of pronotum coarse and regular; interspaces between punctures on foremargin and on hindslope less than or equal to punctures. Scutellum longitudinal, weakly punctate. Elytra 3 times longer than total width, parallel from the shoulders for about 2/3 of their length, converging conically posterad, punctures in the striae longitudinally produced, like dashes; intervals broad, flat, finely and sparsely punctured; epipleura of elytra narrow, barely swollen in front, very smoothly fading out behind. 11 mm.

In the flood-plain forests of Central Asia, in rotting timber of Populus diversifolia Schrenk. Described by Reitter from Tashkent.

Material: 1 female from the neighborhood of Andizhan, May 13-17, 1911.

ELATER URALENSIS GURJEVA.

Gur'eva, 1954, Tr. ZIN AN SSSR, XVI: 198.

The entire beetle is reddish brown, dorsum and venter invested with fine yellow hairs. Head transverse with coarse umbilicate punctures, the interspaces between which are smaller than the punctures. 2nd antennal segment barely longer than broad; 3rd segment conical, appreciably longer than 2nd and a little shorter than 4th; segments, beginning from 4th, 1½-2 times longer than their breadth at apex. Pronotum weakly transverse, its greatest width behind middle, roundly converging anterad, with barely discernible impressions behind, hind angles with indistinct carinae, basal surface almost indistinguishable, median suture weak on hindslope, puncturation of disk sparse and irregular; punctures on foremargin large, umbilicate, denser than on hindmargin where they are simpler and shallower. Scutellum produced, coarsely punctate, weakly carinate. Elytra roughly

*Part I: Entomologicheskoe obozrenie, No. 2, 1957.

**Only the important and recent works are cited. References are given briefly; for full titles see Literature Cited.

3 times as long as total breadth, parallel-sided to last third, punctures in striae round, intervals flat at base, convex at apex, coarsely punctate; epipleura as in E. fulvus Rtt., 10 mm.

In rotting wood of Populus nigra L.

Distribution: middle course of R. Ural.

Material: 1 specimen from southern part of middle course of R. Ural.

ELATER TAURICOLA GURJEVA, sp. n.

Head, pronotum and elytra brownish black, venter dark brown, antennae and legs pale brown; dorsum with fine brown pubescence, venter with dark yellow pubescence. Head (without eyes) as long as broad in males, weakly transverse in females, with two pits, coarsely and densely punctate, interspaces between punctures smaller than punctures. Tips of antennae not extending beyond base of pronotum, equally pubescent in males and females; 2nd segment as long as broad; 3rd segment triangularly dilated, almost equal in size to 4th, less strongly dilated in females; length of remaining segments 1½-2 times their width at apex. Pronotum longer than broad, parallel-sided, converging roundly only at the extreme foremargin, barely discernible emarginations sometimes present in front of hindangles; hindangles with prominent additional carinae; basal surface and median suture absent; puncturation on disk coarse, uniform in density, interspaces between punctures on fore margin and hindslope smaller than, or equal to, punctures, but punctures on hindslope scarcely shallower than on foremargin; punctures on lateral margin large, very dense, weakly produced longitudinally, all umbilicate. Scutellum very elongate. Elytra roughly 3 times longer than total breadth, parallel-sided from shoulders to middle, smoothly converging behind middle, striae not reaching foremargin, deep at base, obsolete at apices, punctures in striae round, intervals flat, but convex on front slope, coarsely rugose at front, finely and sparsely punctate behind; epipleura very swollen at front, smoothly converging behind. Foretibiae normal, not delated, 9-11 mm.

Material and distribution: 3 specimens from the Crimea: Sevastopol, July 1914 (Pliginskii; holotype); Sevastopol, July 27, 1911 (Martynov); Mangup-Kale, July 21, 1907 (Pliginskii); Mukhalatka, July 8, 1902 (N. Kuznetsov).

In the subgenus Ectamenogonus it occupies a special position since the antennae in the males do not bear laterally protruding hairs on their inner margin. Externally very similar to E. megerlei Lac., but differing from it in the shape of the 3rd antennal segment, and in the form of the pronotum and foretibiae.

Subgenus Elater s. str.

Second Group of Species

ELATER ADRASTOIDES RTT.

Reitter, 1896, Wiener Entom. Zeit., 15; 289; Reitter, 1918, 37; 101.

Black, venter may be paler, antennae and legs pale rufous; dorsum invested with black hairs, venter with yellow hairs. Head with umbilicate, large, but sparse punctures, 1-2 punctures could occupy one interspace between punctures, antennae serrate, beginning from 4th segment; 2nd segment longer than broad, barely shorter than 3rd; 3rd approximately 2/3 length of 4th; remaining segments longer than their widths at apex. Pronotum broader than long, wider than elytra, very round, greatest width immediately behind middle; basal surface in form of a half moon lying opposite scutellum; median suture absent; puncturation of disk very fine, sparse, slightly irregular, denser on sides. Greatest width of elytra in hind third, sometimes very weakly expressed; punctures in striae large, longitudinally produced, intervals at base flat, on hind third barely convex, with sparse punctures, rugose; epipleura barely noticeably swollen on foremargin, gradually fading out behind. 5-5.5 mm.

Distribution: eastern Siberia, Ussuri Territory.

Material: 3 specimens.

ELATER ERYTHROGONUS MÜLL.

Müller, Germar, 1821, Magaz, Ins., 4: 186; Candèze, 1859, 2: 468; Szombathy, 1910, 8: 585; Reitter, 1889, 15: 115; Reitter, 1918, 37: 99; Palm, 1947: 160; Jagemann, 1940, 3: 50; Jagemann, 1955: 89.

Black, hindangles and extreme foreangles of pronotum red, sometimes the epipleura of prothorax and last abdominal sternites red, antennae and legs rufous. Venter and red colored spots on pronotum with yellow hairs; head black colored, part of pronotum and elytra with black hairs. Head with coarse umbilicate punctures, the interspaces between which are less than, or equal to, them; head in females slightly impressed. Antennae as in E. adrastoides Rtt., but 3rd segment equal to 2nd and half as long as 4th. Pronotum with greatest width approximately central and with small emarginations (sometimes absent in males) in front of hindangles, roundly converging anterad and center; basal surface absent, median suture either absent, or distinct on hindslope. Puncturation of pronotum and form of elytra as in E. adrastoides Rtt.; elytral striae deeper at foremargin, usually almost completely fading out at hindmargin; epipleura not swollen at front, rather sharply fading out behind. 5.5-7.3 mm.

Larvae in rotten wood and in dust under bark of deciduous and coniferous trees.

Distribution: central and southern Europe, the Caucasus.

Material: 19 specimens.

ELATER SINATUS GERM.

Germar, 1844, Zeitschr. f. Entom., 5: 170; Candèze, 1859, 2: 467; Szombathy, 1910, 8: 585; Reitter, 1889, 15: 115; Reitter, 1918, 37: 99; Jagemann, 1940, 3: 51; Jagemann, 1955: 88.

Close to E. erythrogonus Müll. Black, posterior halves of pronotum and epipleura of prothorax red, tarsi pale brown, dorsum with black, venter with yellow hairs. Differs from E. erythrogonus Müll. also in that the median suture is never distinct even on hindslope, elytra parallel-sided to last third, their intervals flat at the suture, more convex at the sides, slightly rugose. 7-10 mm.

Distribution: southern and central Europe, the Caucasus.

Material: 19 specimens.

Third Group of Species

ELATER SATRAPA KIESENW.

Kiesenwetter, Naturgesch. Ins. Deutschl., 1958: 338; Szombathy, 1910, 8: 587; Reitter, 1889, 15: 111; Reitter, 1918, 37: 89; Dorn, 1922, Entom. Jahrb., 31: 118; Jagemann, 1940, 3: 48; Jagemann, 1955: 71.

sanguineus Lucas, 1849, Explor. Algerie, 2: 163.

var. dibaphus Schiödte, 1865, Naturh. Tidsskr., 3: 533; Reitter, 1889, 15: 111; Reitter, 1918, 37: 89; Jagemann, 1940, 3: 48; Jagemann, 1955: 71.

cinnaberinus Seidlitz, Fauna Baltica, 1888, ed. 2: 180.

dibaphoides Buysson, 1887, Bull. Soc. Entom. France: XC.

forticornis Schwarz, 1900, Deut. Entom. Zeitschr.: 99; Szombathy, 1910, 8: 587; Reitter, 1918, 37: 89.

Black, tarsi brown, elytra dark red; elytra with coarse black hairs, venter with fine, pronotum and head with coarse, yellow pubescence. Head coarsely punctate, intervals between punctures equal to, or less than, punctures. Antennae serrate, beginning from 3rd segment; 2nd segment as long as broad; 3rd segment triangular, in females sometimes subtriangular, but always densely punctate and mat, as are all the following segments; segments, beginning with 4th, as long as their breadth at apex, or slightly longer. Pronotum as long as broad, its greatest width at base or behind middle; basal surface in form of a narrow strip with a slight blunt-tipped expansion in middle, or in form of triangle opposite scutellum; median suture absent or rudimentary on hindslope; puncturation of disk irregular, punctures umbilicate along whole lateral margin. Elytra parallel-sided to hind third, rarely their greatest width is at base, punctures in striae round, dark in front, intervals flat, sparsely punctured weakly rugose; epipleura barely swollen in front, fading out sharply behind. 8-12 mm.

A variation, dibaphus Schiödte, differs in the black pubescence of head, pronotum and sometimes venter. 11-13 mm.

Inhabits oak, birch, and lime (Husler, 1940; Jagemann, 1955).

Distribution: central and southern Europe, the Caucasus, ? the Far East (Yakobson, 1908).

Material: 24 specimens from the Caucasus.

ELATER LENKORANUS RTT.

Reitter, 1889, 15: 111; Reitter, 1918, 37: 88.

Close to E. satrapa Kiesenw.; it differs from it in the basal surface being unbounded at front, the median suture being weaker, the puncturation of the pronotum sparser, and the smaller size of body on the average. 9-11 mm.

Distribution: Armenia, Talysh.

In our series of E. satrapa Kiesenw. from the Caucasus, in particular from Talysh, the characters separating these species are very variable, there being all transitions from the typical E. satrapa Kiesenw. to E. lenkoranus Rtt., and hence the independence of the latter is doubtful; however, in view of the fact that we lacked the type, this question is left unsettled.

ELATER KOENIGI SEM.

Semenov-Tyan-Shanskii, 1891. Tr. RÉO, 25: 348; Reitter, 1918, 37: 88.

Very close to E. satrapa Kiesenw. It differs from it in the following characters: elytra bright red, venter with long rufous pubescence, dorsum with fine black pubescence; elytra always with greatest width at base, whence they gradually converge back; intervals between elytral striae weakly convex at base, strongly so at apex; epipleura swollen at front, smoothly converging behind. 8-11.3 mm.

Distribution: Black Sea coast of the Caucasus.

Material: 14 specimens.

ELATER ANTONIAE RTT.

Reitter, 1889, 15: 113; Reitter, 1918, 37: 88.

Black, legs blackish brown, elytra yellow, entirely covered with golden-yellow pubescence. Antennae as in E. satrapa Kiesenw. Pronotum approximately as long as broad, its greatest width at base, whence it barely noticeably converges to the middle, and from middle anterad converges sharply with straight margins; basal surface in form of narrow strip, slightly expanded opposite scutellum; median suture distinct on hindslope. Sculpture of pronotum and elytra as in E. satrapa Kiesenw. Epipleura barely swollen at front. 9-9.5 mm.

Described by Reitter from the Araks valley in the Caucasus.

Material: 1 specimen: Novorossiisk, VI (N. Bogdanov-Kat'kov).*

ELATER HIRTICOLLIS SEM.

Semonov-Tyan-Shanskii, 1891, Tr. RÉO, 25: 348; Reitter, 1918, 37: 97.

Black, antennae, legs and end of abdomen paler, elytra carmine; dorsum with black, venter with dark grey, hairs. Antennae as in E. satrapa Kiesenw. Form of pronotum as in E. antoniae Rtt.; median suture always absent, basal surface in form of broad, laterally rounded area opposite scutellum; puncturation of disk dense, irregular, punctures simple on lateral margins of hind third. Elytra parallel-sided to hind third; striae stopping well short of foremargin, their punctures coarse, round and darker than intervals, very deep and large punctures at the shoulders in striae 5-7, while in striae 1-4 they are indistinct, black and relatively flat; intervals weakly convex, with round, rather sparse punctures, not rugose; intervals 6-7 more densely punctate at shoulder; epipleura as in E. koenigi Sem. 11.5 mm.

Material: 1 specimen (holotype): Caucasus, Lagodekhi (L. Mlokosevich).

*Year of capture not given.

Fourth Group of Species

ELATER REITTERI SEM.

Semenov-Tyan-Shanskii, 1891, Tr. RÉO: 348; Reitter, 1918, 37: 95.

Black, elytra orange-yellow, tarsi brown; head and pronotum with black hairs, venter with brown, elytra with reddish yellow, hairs. Head coarsely and very densely punctate; interspaces between punctures transformed into narrow ribs separating punctures; 2nd antennal segment as broad as long; 3rd triangular, of much smaller size than 4th; 4th and 5th segments as broad as long; 6-9th segments broader at apices. Pronotum approximately as broad as long, its greatest width at base, weakly roundly converging anterad; basal surface and median line absent, sometimes median line can be distinguished on hindslope; puncturation of disk irregular, exceptionally coarse and dense, interspaces between punctures much smaller than punctures, all punctures umbilicate. Elytra parallel-sided for approximately 3/4 of their length, striae not reaching foremargin, their punctures round, deep, dark, intervals convex, smooth, very weakly and sparsely punctate; epipleura weakly swollen at front; rapidly fading out behind. 11 mm.

Distribution and material: Karateginskii Range, Kizil-Su, 2420 m, June 19, 1889 (Grombchevskii: holotype); Gissar Range, Kondara, 1100 m, May 13, 1937 (Gussakovskii); Pskem Range, Pskem, June 9, 1907 (Zarudnyi).

ELATER FERGANENSIS STEP.

Stepanov, 1935, Ent. Nachrichtenbl., 9: 196.

Close to E. reitteri Sem. Differs from it in the following characters: elytra carmine; head, pronotum and venter with black, elytra with rufous, hairs; width of middle segments of antennae at apices greater than their length, basal surface in form of a trapezium opposite scutellum, median suture well developed and usually traceable to foremargin, punctures on foremargin of elytral striae with indistinct outlines merging together, an area at shoulder, in intervals 6-7, densely punctate and rugose. 10-13 mm.

Species described from Fergena.

Material: 10 specimens from the hills of Tadzhikistan and 1 specimen from the foothills (Stalinabad).

Fifth Group of Species

ELATER BALTEATUS L.

Linné, 1758, Syst. Nat., ed. 10: 405; Candèze, 1859, 2: 543; Szombathy, 1910, 8: 584; Reitter, 1889, 15: 113; Reitter, 1918, 37: 95; Palm, 1947: 161; Jagemann, 1940, 3: 50; Jagemann, 1955: 82.

Black, tarsi brown, elytra red, their apical third (sometimes less than a third) black; entirely covered with black hairs. Head with coarse, umbilicate punctures, interspaces smaller than punctures. Length of 2nd antennal segment equal to width or a little greater than it; 3rd segment barely or 1½ times greater than 2nd; other segments longer than their breadth at apex. Length of pronotum equal to breadth or a little greater than it; its greatest width approximately central; basal surface in form of very small triangle opposite scutellum, sometimes absent; median line distinct on hindslope or absent, puncturation of disk regular, fine; sometimes in males the punctures on the extreme hindslope are shallower than at foremargin. Greatest width of elytra in their hind third; punctures in striae round or produced longitudinally; intervals weakly convex, coarsely punctate, slightly rugose; epipleura not swollen anteriorly, smoothly converging posteriorly. 8-10 mm.

Develops in rotten wood of deciduous and coniferous trees.

Distribution: Europe, the Caucasus, Siberia, the Far East, north Mongolia.

Material: 505 specimens.

ELATER LATIUSCULUS RTT.

Reitter, 1889, Deutsche Entom. Zeitschr.: 260; Reitter, 1918, 37: 95. rubidus Reitter, 1889, 15: 112.

Differs from E. balteatus L. in the unicolorous brownish red elytra, sometimes yellow pubescence on the venter, the shape of the basal surface, which has form of a two-apexed expansion opposite scutellum; always round deep, dark punctures in elytral striae; sparsely punctured, smooth intervals and the shape of the epipleura, which are very slightly expanded anteriorly, and converge sharply posteriorly. 10.5-12 mm.

Distribution: southeast Siberia, the Amur area, the Maritime Territory, Sakhalin.

Material: 7 specimens.

ELATER EURINUS TSHEREPANOV.

Cherepanov, 1957, Click-Beetles of Western Siberia: 205.

Differs from E. balteatus L. in the following characters: black; antennae, tarsi and elytra brown in forehalf; dorsum with fine grey, venter with golden yellow, pubescence; antennal segments, beginning from 3rd, except last, as broad as long; basal surface in form of rectangle; elytral striae deep, their punctures elongate-oval, intervals convex, rugose. 7 mm.

Distribution and material: Bestyakh on R. Sasabyt, Yakutsk region, June 14, 1902 (Naumov; 1 specimen). Boguchan on the Angara, Yenisei, June 6, 1927 (Valdaev, 1 specimen).

ELATER OGLOBLINI DENISOVA

Denisova, 1948, Éntom. obozr., 30: 47.

Head, round spot on pronotum close to foremargin, prothorax (without epipleura), meso- and metathorax and elytra black; remainder of pronotum, antennae, prothoracic epipleura and legs rufous-red; abdomen rufous-red to brownish black; dorsum with long, venter with short, golden yellow hairs. Length of 2nd antennal segment scarcely longer than breadth, form of remaining segments as in E. balteatus L. Pronotum sometimes slightly transverse, but then it is not broader than elytra, its greatest breadth behind middle, slightly emarginate in front of hindangles, roundly converging anterad; basal surface in form of broad triangle, sometimes absent, mean line may be fairly distinct or absent; puncturation of disk fine, sparse, uniform. Form and sculpture of elytra and form of epipleura as in E. balteatus L. 6-7 mm.

Distribution: Mountanous Tadzhikistan and hills of Kirgizia.

Material: 5 specimens.

Sixth Group of Species

ELATER PARTRICIUS GURJEVA, SP. N.

Black, tarsi brown, elytra brownish red in forehalf, black in hindhalf, the black color wedging itself along the suture into the reddish half, elytral epipleura red, anteriorly with a black spot, which is sometimes not developed; venter and front slope of elytra with yellow hairs, head, pronotum and rest of elytra with black hairs. Head invested with comparatively small umbilicate punctures, the intervals between which are equal to them, or smaller here and there. Tips of antennae do not extend beyond the hindangles of the pronotum, serrate from 4th segment; 2nd segment as broad as long, 3rd conical, 1½-2 times longer than 2nd, length of middle segments a little greater than their width at apices. Pronotum of approximately equal length and breadth or length just exceeds breadth, parallel-sided from base to fore third, converging roundly anteriorly; basal surface in form of a triangle, the apex of which gradually merges into the hindslope; median suture absent or barely noticeable on hindslope, puncturation of disk very fine and sparse, uniform, pucturation denser on lateral margin, punctures simple in hind half. Greatest width of elytra at base or they are parallel-sided up to hind third, striae stop well short of fore margin, punctures in striae round, indistinctly outlined in first five striae at base, intervals densely punctate, very weakly rugose; epipleura very weakly swollen in front, smoothly converging behind. 9-10.5 mm.

The species was recorded under this name as a new species by A. N. Reikhardt. 3 specimens from the Far East – Yakovlevka, Spasski district, Ussuri Territory – May 25, 1926 (D'yakonov and Filip'ev; holotype); Sedanka, near Vladivostok, Aug. 9, 1912 (Berger); Khabarovsk, Primorskaya region, June 23, 1916 (Pavlenko).

ELATER GRACILIS GURJEVA SP. N.

Black, legs, sometimes antennae brown, elytra reddish yellow; venter and front slope of elytra with yellow hairs, remainder of dorsum with black hairs. Head with small umbilicate punctures, the interspaces between which in places are less than punctures, in places equal to them. Tips of antennae do not extend beyond hindangles of pronotum; 2nd segment small, as broad as long; 3rd conical, 1½-2 times longer than 2nd; length of middle segments greater than their width at apex. Pronotum as broad as long; pronotum parallel-sided from hindangles to middle, rarely with barely distinguishable emarginations, converging weakly roundly at front; basal surface rudimentary, median suture scarcely visible on hindslope; puncturation of disk very fine and sparse, uniform, denser on lateral margin, punctures in hind half simple. Elytra parallel-sided for 2/3 to 3/4 of their length; striae stop well short of foremargin, punctures round, dark, larger at foremargin, sometimes indistinctly outlined; intervals convex, very finely punctate; epipleura not swollen at front, converging sharply behind. 9-11 mm.

Distribution and material: 4 specimens form the Far East – Glonskii canal, 230 versts below Khabarovsk, May 26, 1911 (Soldatov; holotype); Sedanka, near Vladivostok, June 9, 1912 (Berger); Tigrovaya, Suchan district, Ussuri Territory, June 29, 1927 (Shtakel'berg); Vinogradovka, Ussuri Territory, May 22, 1929 (Kirichenko).

Seventh Group of Species

ELATER TRISTIS L.

Linné, 1758, Syst. Nat., ed. 10, I: 406; Candèze, 1859, 2: 460; Szombathy, 1910, 8: 584; Reitter, 1889, 15: 115; Reitter, 1918, 37: 98; Palm, 1947: 160; Jagemann, 1940, 3: 50; Jagemann, 1955: 87.

Black, narrow strips along lateral margins of elytra and spots on them at shoulders brownish yellow; dorsum with black, venter with yellow, hairs. Head with coarse umbilicate punctures, interspaces smaller than them. Length of 2nd antennal segment equal to width or barely longer than width; 3rd segment conical, scarcely longer than 2nd; length of remaining segments greater than their width at apex. Pronotum as broad as long, greatest width approximately in middle, with weak emarginations before the hindangles, sometimes parallel-sided behind, roundly converging in front; basal surface rudimentary, in form of a very small half-moon, the median line on hindslope distinct; disk pucturation of uniform density, interspaces between punctures smaller than,or equal to, punctures, punctures may be shallower on hindslope. Elytra parallel-sided to hind third, converging like a cone behind, punctures in striae round, intervals weakly convex, very coarsely rugose; epipleura in front weakly swollen, clavate. 7.5-10 mm.

Lives in various rotten deciduous and coniferous trees.

Distribution: north and central Europe, Siberia, the Far East, north Mongolia.

Material: 101 specimens.

ELATER SOBRINUS MOTSCH.

Motschulsky, 1860, Schrenck's Reisen Amurl: III; Reitter, 1918, 37: 102.
compactus Reitter, 1889, 15: 116; Reitter, 1918, 37: 100.
christophi Jacobson, 1913, Beetles of Russian and Western Europe 10: 750.

Close to E. tristis L. It differs from it in the uniform black coloration, and also in the fact that the width of the pronotum sometimes slightly exceeds its length (but it is never wider than elytra), and in the more convex elytral intervals. 7-8.5 mm.

Distribution: Taiga zone of the European USSR (Leningrad Region; first records), Siberia, Far East.

Material: 114 specimens.

Eighth Group of Species

ELATER PRAEUSTUS F.

Fabricius, 1792, Ent. Syst., I: 229; Candèze, 1859, 2: 368; Szombathy, 1910, 8: 584; Reitter, 1889, 15: 111; Reitter, 1918, 37: 96-98; Dorn, 1922, Entom. Jahrb., 31: 119; Palm, 1947: 159; Jagemann, 1940, 3: 49; Jagemann, 1955: 85.

exsangius Eschscholtz, B: Seidlitz, Fauna Baltica, 1888, ed. 2: 80.
aster Rye, 1905, Entom. Mon. Mag., 2: 355, 357.
coccinatus Rye, 1867, Entom. Mon. Mag., 3: 249.
subdepressus Rye, 1887, Essai Larves Col.: 78.
talyschensis Reitter, 1889, 15: 96.

Black, tarsi brown, elytra red with black tips, sometimes without blackening; dorsum with black or yellow pubescence, sometimes base and margins of elytra with yellow hairs and remainder with black hairs, venter with brown or yellow pubescence. Head with coarse umbilicate punctures, the interspaces between which are less than the punctures. Length of 2nd antennal segment roughly equal to its width; 3rd segment conical, 1½ times longer than 2nd, length of middle segments a little greater than their width at apex. Pronotum longer than broad, its greatest width in fore third, posterad of which it is almost parallel-sided; basal surface in form of a narrow strip along entire basal margin; median suture either barely discernible on hindslope or can be followed to foremargin, puncturation of entire pronotum uniform, large, coarse, intervals between punctures less than punctures or equal to them in some places, sometimes in males the punctures on the basal surface are shallower and are very slightly sparser than on disk. Elytra parallel-sided to hind third, punctures in striae very coarse round, rather deep, usually dark; punctures on foremargin in inner four striae merging to form transverse black spots, intervals with shallow punctures, weakly rugose; epipleura strongly swollen at front. 9-13 mm.

Mainly inhabits conifers, but also occurs on deciduous trees.

Distribution: Europe, the Caucasus, west Siberia.

Material: 183 specimens.

ELATER PULCHER BAUDI.

Baudi, 1871, Berl. Entom. Zeitschr. 15: 51; Reitter, 1889, 15: 113; Reitter, 1918, 37: 97.

This species is very close to E. praeustus F.; it differs from it in its smaller size, paler coloration of elytra (with yellowish tinge) and complete absence of median suture. The color of pubescence also varies, as in E. praeustus F. It is very easily confused with small E. praeustus var. tauricus Rtt. It is quite possible that this is not an independent species. Unfortunately, the material (absence of type) does not enable us to decide definitely in the meantime.

Distribution: south Europe, Crimea, the Caucasus.

Material: 12 specimens.

ELATER CIRCASSICUS RTT.

Reitter, 1887, Wien. Entom. Zeit., 6: 212; Reitter, 1889, 15: 114; Reitter, 1918, 37: 98.

Black, antennae, legs and abdomen may be blackish brown, elytra straw-yellow; dorsum with black or yellow hairs, venter with brown hairs. Antennae as in E. praeustus F., but length of the middle segments is approximately equal to their width at the apex. In form of pronotum we note two groups, with all transitional stages between: 1) pronotum has greatest width centrally, converging smoothly behind, sharply forward, wider than elytra; 2) its greatest width at base, whence it is almost parallel-sided to fore third, sharply converging anterad, not wider than elytra; basal surface in form of a strip along entire basal margin; median suture indistinct on hindslope; puncturation of pronotum, form and sculture of elytra as in E. praustus F. 8-12,5 mm.

Distribution: the Caucasus.

Material: 29 specimens.

ELATER AETHIOPS LAC.

Lacordaire, 1835, Fauna Entom. Paris, I: 657, Candèze, 1859, 2: 472; Szombathy, 1910, 8: 584; Reitter, 1918, 37: 100; Jagemann, 1940, 3: 51; Jagemann, 1955: 91.
brunnicornis Germar, 1844, Zeitschr. f. Entom. 5: 173.
scrofa Germar, 1844, Zeitschr. f. Entom. 5: 173.

foveicollis Candèze, 1859, 2: 474.
scrofa Redtenbacher, 1858, Fauna Austriaca, ed. 2: 500.
subsp. turanus Semenov, 1891, Tr. RÉO, 25: 349.

Black, sometimes the antennae, elytral epipleura, abdomen, legs and occasionally the prothorax brownish black to brown; dorsum and venter with fine black pubescence. Pronotum as broad as long, greatest width in middle, whence it rather sharply converges anterad, almost parallel-sided from middle posterad; basal surface absent. Sculpture of pronotum and elytra as in E. praeustus F. Elytra in middle or very slight behind it barely noticeably expanded; epipleura at front swollen, clavate. 10-12.5 mm.

Subsp. turanus Sem. is distinguished from the main form by the fact that the dorsum has greyish, and venter brown, pubescence; a slightly more elongated beetle, more elegant. 10.5 mm.

It lives predominantly in conifers (Husler 1940), but sometimes occurs on deciduous trees (Jagemann, 1955).

Distribution: Europe, Syria, Asia Minor, Central Asia, Siberia.

Material: 13 specimens of main form and 9 specimens of the subsp. turanus Sem.

ELATER GANGLBAUERI RTT.

Reitter, 1889, 15: 113; Reitter, 1918, 37: 96.

Black, tarsi or entire legs, abdomen, occasionally antennae, may be paler, elytra red; dorsum with long, venter with short, yellow pubescence. Form of antennae and pronotum as in E. praeustus F.; characteristic features are the beak-like, downturned hind angles of pronotum; basal surface not developed, in the form of a barely discernible half-moon opposite scutellum; median suture either absent or just distinguishable on hindslope. Sculpture of pronotum and elytra as in E. praeustus F.; epipleura very slightly expanded anteriorly, converging smoothly posteriorly. 8.5-10 mm.

Distribution: north Caucasus, Transcaucasis, northeast Turkey.

Material: 13 specimens.

Ninth Group of Species

ELATER SANGUINEUS L.

Linné, 1758, Syst. Nat., ed. 10, 1: 405; Candèze 1859, 2: 442; Szombathy, 1910, 8: 585; Reitter, 1889, 15: 110; Reitter, 1918, 37: 85; Palm, 1947: 168; Jagemann, 1940, 3: 48; Jagemann, 1955: 68.
haemelyter Schrank, 1798, Fauna Boica: 590.
rufipennis Stephens, 1830, Illustr. Brit. Entom. Mandib., 3: 256.
semiruber Stephens, Illustr. Brit. Entom. Mandib. 3: 257.

Head, antennae, pronotum, entire venter and legs black, sometimes tarsi brown, elytra bright red. Second antennal segment as long as broad; 3rd segment broadly conical, 1½-2 times longer than 2nd; length of remaining segments barely greater than width at apex, or equal to it. Length of pronotum equal to its width or slightly greater than it; greatest width behind middle, slightly emarginate before hindangles, roundly converging anterad; basal surface in form of a narrow strip along basal margin with an acute-triangular expansion opposite scutellum; median suture distinct on hindslope, often traceable right up to foremargins, all punctures umbilicate. Greatest width of elytra at base, sometimes they are parallel-sided to hind third, punctures in striae round, transverse with indistinct outlines on foremargin, dark; intervals convex, with sparse punctures, weakly rugose; epipleura swollen anteriorly, converging sharply posteriorly. 12.5-17 mm.

Develops exclusively in conifers, under bark and in rotten wood. The species though rarely, is nevertheless found on deciduous trees (Korschefsky, 1941).

Distribution: Europe, Caucasus, Siberia.

Material: 246 specimens.

ELATER CINNABARINUS ESCH.

Eschscholtz, 1829, Entom. Arch., 2, 1: 33; Candèze, 1859, 2: 443; Szombathy, 1910, 8: 584; Reitter, 1918, 37: 84; Palm, 1947: 168; Jagemann, 1940, 3; Jagemann, 1955, 66.

sanguineus Scopoli, 1763, Entom. Carniol.: 94.

lythropterus Germar, 1844, Zeitschr. f. Entom., 5: 156.

This species is similar to E. sanguineus L.: it differs from it in the form of the basal surface, which consists of a narrow strip along the basal margin with a two-apexed, rarely a blunt one-apexed, expansion opposite scutellum. Usually these species differ in the color of the pubescence of the head and pronotum: in E. sanguineus L. it is always black, in E. cinnabarinus Esch. it is usually yellow or brown. Yet ab. atropilosus Rye has the same pubescence as E. sanguineus L. Besides this, E. sanguineus L. is larger on the average than E. cinnabarinus Esch. 11-14 mm.

It lives in the wood of deciduous trees.

Distribution: Europe, the Caucasus, Asia Minor, Far East, Siberia.

Material: 187 specimens.

ELATER OCHROPTERUS GERM.

Germar, 1884, Zeitschr. f. Entom., 5: 160; Candèze, 1859, 2: 450; Reitter, 1889, 15: 114; Reitter, 1918, 37: 87; Roubal, 1921, Entom. Blätter, 17: 135.

m. coenobita Costa, 1881, Atti Real. Accad. Napoli, 9: 34; Reitter, 1889, 15: 114; Reitter, 1918, 37: 86.

Black elytra straw-yellow; entire beetle with yellow hairs, elytra sometimes with black pubescence. Form of anetennal segments and pronotum as in E. sanguineus L., sometimes 3rd segment of antennae slightly triangularly dilated (ab. auranticulus Rtt.); form of basal surface varying greatly. Sculpture of pronotum, its form, and nature of elytral sculpture as in E. sanguineus L., but puncturation of intervals sparser. 11-14.5 mm.

On oak and willow (Buysson, 1896).

Distribution: southern Europe, forest regions of Caucasus, southern Siberia.

Material: 74 specimens.

M. COENOBITA COSTA

Differs from E. ochropterus Germ. in that the whole dorsum has black pubescence (elytra sometimes with yellow hairs) and its larger average size. 12-15 mm.

Distribution: southern Europe, forest regions of Caucasus.

Material: 30 specimens.

Reitter considers it as an independent species on the basis of the color of the pubescence and the form of the basal surface, which in E. ochropterus Germ. is allegedly of the same form as in E. cinnabarinus Esch., while in E. coenobita Costa it is the same as in E. sanguineus L. In the material present in the collection of ZIN AN SSSR there could not be established any regularity in the form of the basal surface of these two forms, and in each case it varied greatly and could have the same form as either E. sanguineus or E. cinnabarinus Esch. This led us to the opinion that E. coenobita Costa cannot be considered as an independent species, and at best (considering the larger size on the average) it may be counted as a morph of E. ochropterus Germ.* Buysson (1896) considers it as a variation of E. ochropterus Germ. 12-15 mm.

ELATER SANGUINOLENTUS SCHRNK.

Schrank, 1776, Beitr. Naturgesch.: 69, Candèze, 1859, 2: 444; Szombathy, 1910, 8: 584; Reitter,

*In the first part of the present work (Gur'eva, 1957) this form was considered as a subspecies.

1889, 15: 112; Reitter, 1918, 37: 90; Palm, 1947: 170, Jagemann, 1940, 3: 49; Jagemann, 1955: 74.
haemopterus Gmelin, 1790, In: Linné, Syst. Nat. ed. 13, I, 4: 917.
coccineus Schiödte, 1865, Naturh. Tidsskr., 3: 533.

Black, tarsi brown, greater part of elytra red, very rarely with yellowish tint, in center of elytra a large, longitudinally produced black spot, which may sometimes be absent (ab. immaculatus Schauf.); elytra with short black, sometimes yellow, hairs; head, pronotum with long brown, venter with yellow hairs. Sculpture of head and form of antennae as in E. sanguineus L., but 3rd segment is narrower median suture of pronotum usually absent, but sometimes discernible on hindslope; puncturation of disk irregular, finer than in E. sanguineus L., punctures denser on lateral margins, always umbilicate, interspaces smaller than punctures, smooth. Elytra expanding slightly in hind third, punctures in striae round, anteriorly in inner striae larger, with less distinct outlines, black, intervals weakly convex, puncturation coarse at base and fine at apex; epipleura as in E. sanguineus L. 9-12.5 mm.

Larvae in rotten wood of deciduous trees.

Distribution: Europe, north Caucasus, Siberia, Far East.

Material: 865 specimens.

ELATER POMONAE STEPH.

Stephens, 1830, Illustr. Brit. Entom. Mandib., 3: 257; Candèze, 1859: 445; Szombathy, 1910, 8: 584; Reitter, 1889, 15: 111; Reitter, 1918, 37: 89; Palm, 1947: 169; Jagemann, 1940, 3: 49; Jagemann, 1955: 72. Cherepanov, 1957, Click Beetles of Western Siberia: 203.
jakowlewi Semenov, 1891, Tr. RÉO, 25: 350; Reitter, 1918, 37: 93.

Close to E. sanguinolentus Schrnk. Elytra entirely black, very rarely yellowish; dorsum with black, sometimes with mixed black and yellow, pubescence; venter with yellow, rarely black, hairs. A characteristic feature is the puncturation on the lateral margins of the pronotum, where the large punctures are situated one against the other, so that the interspaces between them are transformed into very narrow ribs; this character distinguishes this species from the very similar E. sanguinolentus ab. immaculatus. 8.5-10 mm.

Predominantly in deciduous trees.

Distribution: Europe, the Caucasus, Siberia.

Material: 403 specimens of E. pomonae Steph. and 2 specimens of E. jakowlewi Sem. (types).

E. jakowlewi Sem. from Irkutsk does not differ in any way from E. pomonae Steph., as Cherepanov (1957) has indicated already.

ELATER AUROSERICEUS GURJEVA, sp. n.

Black tarsi brown, elytra orange; head, pronotum and venter with fine black, elytra with reddish yellow, pubescence. Head slightly impressed in middle with coarse umbilicate punctures, the interspaces being much smaller than punctures. Antennae not extending beyond hindangles of pronotum, serrate from 4th segment; length of 2nd segment equal to breadth or barely longer than it; 3rd segment conical, 1½ times longer than 2nd; length of remaining segments appreciably longer than their width at apex. Pronotum as broad as long, its greatest breadth behind middle, anterad strongly, posterad barely noticeably, converging; basal surface in form of a very small strip opposite scutellum, not demarcated anteriorly; median suture absent; puncturation of disk dense, slightly irregular; punctures on hind slope much smaller, but interspaces scarcely larger than on foremargin, dense umbilicate punctures along entire lateral margins, interspaces much smaller than punctures. Elytra slightly expanded in hind third or parallel-sided to hind third, rounded at apices, striae deep, stopping well short of foremargin, punctures in striae small, round, intervals convex, very finely punctate, smooth, epipleura very slightly expanded anteriorly, smoothly converging posteriorly. 11-12 mm. Externally similar to E. nigroflavus Goeze., and in sculpture resembling E. sanguinolentus Schrnk.

Distribution and material: 3 specimens from west Tyan-Shan: Khodzha-Ata-Su, near Namangan, Aug. 17,1927 (Dzenslitovskaya; 2 specimens, one of them the holotype); Pskem, July 9,1907 (Zarudnyi; 1 specimen).

ELATER BASALIS MANNH.

Mannerheim, 1852, Bull. Moscow, 25, 4: 291; Candèze, 1859, 2: 483; Reitter, 1889, 15: 115; Reitter, 1918, 37: 99.

Black, small spots on base and epipleura of elytra yellow, legs and antennae brown; black colored part of dorsum with black hairs, yellow colored part and venter with yellow hairs. Puncturation of head and antennae as in E. sanguinolentus Schrnk. Length of pronotum greater than its breadth, very rarely equal to it, greatest breadth in middle. Basal surface and puncturation of pronotum as in E. sanguinolentus Schrnk., median suture present on hind slope. Elytra parellel-sided to hind third, striae stopping well short of foremargin, punctures in them longitudinally produced, intervals convex, with large punctures; epipleura as in E. pomonae Steph. 8.5-12 mm.

Distribution: south of east Siberia, Amur area, Maritime Territory, Japan.

Material: 59 specimens.

ELATER NIGERRIMUS LAC.

Lacordaire, 1835, Fauna Entom. Paris, I: 657; Candèze, 1859, 2: 474; Szombathy, 1910, 8: 584; Reitter, 1889, 15: 116; Reitter, 1918, 37: 100; Palm, 1947: 160; Jagemann, 1940: 3, 51; Jagemann, 1955: 92.
aethiops Fowler, 1890, Col. Brit. Isl., 4: 92.
brunnicornis Germar, 1844, Zeitschr. f. Entom., 5: 137.
obsidianus Germar, 1844, Zeitschr f. Entom. 5 : 174.

Black, tarsi paler, entirely covered with black pubescence. Antennae as in E. sanguineus L. Pronotum as broad as long, its greatest breadth in middle; basal surface in form of a half-moon; median suture absent, rarely just discernible on hindslope; puncturation of pronotum and form of elytra as in E. sanguineus L., striae reaching foremargin, punctures in striae longitudinally produced, intervals weakly convex, rugose; epipleura very swollen anteriorly, smoothly converging posteriorly. 8.5-10 mm.

In wood dust of oak (Palm, 1947; Jagemann, 1955) and also in spruce stumps (Husler, 1940).

Distribution: central and southern Europe.

Material: 12 specimens.

Tenth Group of Species

ELATER COMPACTUS CAND.

Candèze, 1891, Catal. Elat: I; Reitter, 1918, 37: 100.
candezei Kraatz. 1879, Deutsche Entom. Zeitschr., 23: 123.

Black, antennae, legs, last sternites of abdomen and sometimes entire abdomen paler, dorsum with black, venter with brown, hairs. Head with coarse and large punctures, interspaces smaller than punctures, equal to them in places. Second antennal segments barely longer than broad; 3rd conical, obliquely cut off at apex, twice as long as 2nd; length of segments from 4th on greater than their width at apex. Length of pronotum equal to breadth or barely longer than it, the greatest breadth approximately central; pronotum arcuate anteriorly, barely noticeably converging posteriorly; basal surface in form of narrow strip with slight expansion opposite scutellum; median suture broad, distinct only on hindslope very rarely fading out completely or traceable to foremargin; puncturation of disk not very coarse, irregular, denser on sides, where the punctures are contiguous in places, always umbilicate. Elytra parallel-sided to hind third; small and rather sparse punctures located in the deep striae, intervals very strongly convex, distinctly punctured, weakly rugose; epipleura narrow, not swollen at front, converging sharply behind. 12.5-15 mm.

Distribution: south of east Siberia, the Amur area, Maritime Territory.

Material: 20 specimens.

Eleventh Group of Species

ELATER POMORUM HBST.

Herbst, 1784, Arch. f. Insectengesch., 5: 112; Candèze, 1859, 2: 446: Dorn, 1924-1925. Entom. Jahrb.: 129; Palm, 1947: 162; Jagemann, 1940, 3: 50; Jagemann, 1955: 78.

crocatus Stephens, 1839, Man. Brit. Col.: 179; Schiödte, 1865, Natur. Tidsskr., 3: 339.

ferrugatus Lacordaire, 1835, Faune Entom. Paris: 655; Szombathy, 1910, 8: 584; Reitter, 1889, 15: 112; Reitter, 1918, 37: 93.

apicalis Schilsky, 1892, Deutsch. Entom. Zeitschr.: 198.

Black, elytra brownish red, very rarely slightly blackened at apex, with black or yellow pubescence. Head coarsely and irregularly punctate, interspaces smaller than punctures in some places, equal to them in others. Antennae serrate from 4th segment; sometimes in females 3rd segment is triangularly expanded, but then it is sparsely punctate and has the same luster as first two; 2nd segment as broad as long or its length is barely greater than breadth; 3rd almost twice as long as 2nd; length of middle segments equal to their breadth at apex or scarcely longer. Pronotum as broad as long, its greatest width behind middle, whence it is parallel-sided or with slight emarginations posterad, roundly converging anterad; basal surface in form of a strip with an expansion in front of scutellum; median suture may be absent, barely discernible or distinct on hindslope; puncturation of disk fine, uneven, punctures simple on lateral margins in hind third. Elytra parallel-sided to hind third, rarely barely noticeably expanded in hind third, punctures in striae round, on foremargin indestinctly delineated and dark; intervals at suture flat, becoming convex toward margins, sparsely punctate, rugose; epipleura swollen at front, gradually converging behind. 9-11 mm.

Develops predominantly in deciduous trees.

Distribution: Europe, Caucasus, Central Asia, Siberia, Far East.

Material: 476 specimens.

ELATER ELONGATULUS F.

Fabricius, 1787, Mant. Inst., I: 174; Candèze, 1859, 2: 451; Szombathy, 1910, 8: 584; Reitter, 1889, 15: 112; Reitter, 1918, 37: 94; Jagemann, 1940, 3: 49; Jagemann, 1955 : 80.

gliscereus Panzer, 1795, Deutschl. Ins. Fauna: 241.

glycereus Herbst, 1884, Arch. f. Insectengesch., 5: 112.

praeustus Stephens, 1830, Illustr. Brit. Entom. Mandib.: 257.

Close to E. pomorum Hbst. Tips of elytra always more or less blackened; 2nd antennal segment a little longer than broad; basal surface developed only opposite scutellum and in shape of triangle or trapezium; pronotum from middle anterad converging more sharply than in E. pomorum Hbst.; median line never distinct, intervals between elytral striae less rugose. 7-9 mm.

This species occurs together with E. sanguinolentus Schrnk. under oak bark (Husler, 1940).

Distribution: north and central Europe, Caucasus, Asia Minor, Siberia.

Material: 81 specimens.

ELATER NIGROFLAVUS GOEZE

Goeze, 1777, Ent. Beytr.: 568; Szombathy, 1910, 8: 586; Reitter, 1918, 37: 93; Palm, 1947: 162; Jagemann, 1940, 3: 49; Jagemann, 1955: 76.

crocatus Lacordaire, 1835, Faune Entom. Paris, I: 655; Candèze, 1859, 2: 449; Reitter, 1889, 15: 114.

flavescens Lacordaire, 1835, Faune Entom. Paris, I: 35.

erubescens Eschscholtz, 1829, Entom. Arch., 2: 33.

gerhardti Pic, 1914, Deutsche Entom. Leitschr.: 319.

Black, antennae, legs and abdomen sometimes paler, elytra yellow- or orange-red; head, pronotum and dorsum with dark or yellow hairs, elytra with long golden hairs. Sculpture of head and pronotum and form of antennae as in E. pomorum Hbst., but 3rd antennal segment is a little or 1½ times length of 2nd; basal

surface triangular, median suture never distinct. Sculpture of elytra as in E. elongatulus F.; epipleura as in E. pomorum Hbst. 9.5-13 mm.

Predominantly in deciduous trees.

Distribution: north and central Europe, Siberia.

Material: 45 specimens.

ELATER ELEGANTULUS SCHÖNH.

Schonherr, 1817, Syn. Ins., I: 303; Candèze, 1859, 2: 457; Szombathy, 1910, 8: 584; Reitter, 1889, 15: 114; Reitter, 1918, 37: 94; Palm 1947: 162; Jagemann, 1940, 3: 50; Jagemann, 1955: 82.
elongatulus Herbst, 1806, Nat. Syst. Ins. Kaf., 10: 97.
adustus Eschscholtz, 1829, Entom. Arch., 2: 33.
austriacus Castelnau, 1840, Hist. Nat. Inst. Col., 1: 244.

Black, legs, terminal segments of antennae, last abdominal sternites, rarely the whole abdomen, may be brown; elytra bright yellow with blackened (1/6 – 1/3) tips, in the third interval at the base a barely discernible puncture; unsually with black, but sometimes yellow, pubescence. Length of 2nd antennal segment equal to its breadth; 3rd segment as broad as long or its length just greater than breadth, equal to or just longer than 2nd. Pronotum as broad as long or length slightly exceeding breadth, almost parallel-sided from base to fore third; basal surface in form of a half-moon; no median suture; puncturation of disk very fine, sparse, uneven, the same on sides as on foremargin; punctures in elytral striae sround, very scattered, dark, intervals weakly convex, with sparse punctures; epipleura as in E. nigroflavus Goeze. 8-9 mm.

In rotten oaks (Palm, 1947), willows and poplars (Jagemann, 1955).

Distribution: Europe, Asia Minor, Caucasus.

Material: 15 specimens.

ELATER DEPLANATUS RTT.

Reitter, 1918, 37: 92.

Similar to E. pomorum Hbst., but tips of elytra never blackened, the greatest width of the pronotum at base, the basal surface in form of a small strip opposite scutellum, median suture absent. Very characteristic are the exceptionally flat elytra, the dash-like punctures in the striae, the intervals very flat, densely punctate, weakly rugose. 10.5-11 mm.

Distribution: eastern Kazakhstan.

Material: 4 specimens.

ELATER ATRIPES RTT.

Reitter, 1896, Wiener Entom. Zeit., 15: 288 (Reitter, 1918, 37: 100).

Black, antennae, legs and abdomen, and rarely the prothorax may be brown; dorsum and venter with black hairs. Antennae as in E. pomorum Hbst. Form of pronotum and basal surface as in E. deplanatus Rtt., median suture absent or indistinct on hindslope; puncturation of pronotum and form of elytra as in E. pomorum Hbst., elytral striae deep, with large, round punctures, intervals weakly convex, weakly rugose. 9.5-11 mm.

Distribution: north Tyan-Shan to Kul'dzhi.

Material: 14 specimens

Twelfth Group of Species

ELATER NIGRINUS HBST.

Herbst, 1784, Arch. f. Insectengesch., 5: 114; Candèze, 1859, 2: 475; Szombathy, 1910, 8: 585; Reitter 1889, 15: 116; Reitter, 1918, 37: 101; Palm, 1947: 160; Jagemann, 1940, 3: 50; Jagemann, 1955: 93.

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? nigrinoides Reitter, 1918, 37: 101.
picitarsis Motschulsky, 1860, Schrenck's Reisen Amurl.: 110; Reitter, 1918, 37: 99.
dilutipes Motschulsky, 1860, Schrenck's Reisen Amurl.: 111; Reitter, 1889, 15: 116, Reitter, 1918, 37: 101.
fulvipes Motschulsky, 1860, Schrenck's Reisen Amurl. 111; Reitter, 1889, 15: 116.

Black, antennae and legs sometimes paler, dorsum with black, venter with yellow, pubescence. Head with umbilicate punctures, interspaces being equal to them, but here and there larger or smaller than them. Second antennal segment scarcely longer than broad, sometimes of equal length and breadth; 3rd segment conical, equal to 2nd, length of middle segments 1½-2 times longer than their breadth at apex. Form of pronotum varying greatly, its length approximately equal to its breadth, rarely slightly shorter or longer than it, its greatest breadth may be at base, whence it gradually converges to hind third; it may be parallel-sided from hindangles to front third and may have greatest breadth before middle, in which case there are barely noticeable emarginations in front of hindangles, and its always converges roundly in front; basal surface and median suture absent, the latter sometimes present on hind slope; puncturation of disk very fine, uneven, punctures on lateral margins denser, posteriorly simple. Elytra slightly expanded in hind third, punctures in striae longitudinally produced, intervals very weakly convex, slightly rugose; epipleura not swollen anteriorly, converging sharply posteriorly. 6.5-8.5 mm.

Develops in deciduous and coniferous trees.

Distribution: Europe, Siberia, Far East, North America.

Material: 205 specimens of E. nigrinus Hbst., 2 E. picitarsis Motsch. and 3 E. dilutipes Motsch (topotypes).

E. nigrinoides Rtt. is apparently none other than E. nigrinus Hbst.

Reitter (1918) states that E. nigrinoides Rtt. is remarkably similar to E. nigrinus Hbst. and has the same shape, size and sculpture, but differs from it in the presence of a short median suture on the hindslope of the pronotum. In our series of E. nigrinus Hbst. however, there are specimens with this character expressed in varied degree. Reitter (1918) in his table places E. nigrinoides Rtt. alongside E. pallipes Kr. on the grounds that these species occur in east Siberia, while E. nigrinus Hbst. is allegedly found only in Europe and North America. But this is not the case: E. nigrinus Hbst. is rather a common species in east Siberia also.

E. dilutipes Motsch. and E. picitarsis Motsch. are topotype from Mochul'skii's collection (the types, unfortunately, were lost during the Great Patriotic War). These specimens are none other than E. nigrinus Hbst. E. fulvipes Motsch. is lacking, but a very brief description of it is given by Mochul'skii with the description of E. dilutipes Motsch., where he separates it from E. dilutipes as a new species on the basis of slight differences in structure.

ELATER NIGROR RTT.

Reitter, 1896, Wiener Entom. Zeit., 15: 288; Reitter, 1918, 37: 102.

Black, tarsi may be paler, whole body covered with yellow hairs. Head with shallow, umbilicate punctures, interspaces smaller than punctures in some places, larger in others. Second antennal segment as broad as long; 3rd segment slightly triangularly expanded, of the same form as subsequent segments, but of smaller size, length of remaining segments more than twice their breadth at apex. Pronotum as broad as long, equally broad in middle and at base, with barely discernible emarginations immediately behind middle, almost rectilineal in front in males, weakly roundly converging in females; basal surface barely discernible opposite scutellum; median line absent or distinct on hind slope; puncturation of disk as in E. nigrinus Hbst. Elytra very produced, parallel-sided to hind quarter striae reaching very foremargin punctures in striae longtudinally produced, intervals almost flat, weakly rugose. Epipleura as in E. nigrinus Hbst. 8-9 mm.

Distribution: south Siberia, the Amur area, Maritime Territory.

Material: 36 specimens.

ELATER PALLIPES KR.

Kraatz, 1879, Deutsche Entom. Zeitschr., 23: 124; Reitter, 1895, Wiener Entom. Zeit., 15: 261; Reitter, 1918, 37: 100.

Black, antennae and legs pale brown; dorsum with black, venter with yellow, hairs. Second antennal segment as broad as long; 3rd segment conical, barely longer than 2nd; length of remaining segments almost twice their breadth at apex. Pronotum as long as broad, or slightly transverse, its greatest width at base; basal surface in form of small half-moon in front of scutellum; median line absent, or present on hindslope; puncturation of disk as in E. nigrinus Hbst. Elytra very elongate, 4 times longer than total breadth, striae almost reaching foremargin, punctures in striae elongate oval, intervals weakly convex, scarcely rugose; epipleura as in E. nigrinus Hbst. 8.5-10 mm.

Distribution: south of east Siberia, the Amur area, Maritime Territory.

Material: 11 specimens.

SUMMARY*

This article contains the description of the species of the genus Elater L. of the fauna of the USSR. Four new species are described. The type specimens are in the collection of the Zoological Institute of the Academy of Science of the USSR.

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A NEW SPECIES OF PSAMMOPHILOUS BEETLE (COLEOPTERA, HISTERIDAE) FROM THE TURKMENIAN SSR

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In the extremely interesting entomological collections made by G. S. and G. N. Medvedev in Badkhyz (southeast Turkmenia) in spring 1957, there was found one specimen of a very distinctive, definitely psammophilous, species of hister beetle (Histeridae), which has not been described heretofore.

From the complex of morphological characters – spindle-shaped body, coarsely punctured frons, presence of tiny setae on the pronotal epipleura and the greatly thickened hindtibiae of triangular cross section – we must assign this species to the genus Exaesiopus Rchdt., in which it most closely resembles E. duriculus (Reitt.), but can be distinguished from it at the first glance by its much larger size and the extremely coarse sculpturing of the dorsum. Its description is given below.

EXAESIOPUS PAVLOVSKII O. KRYZHANOVSKIJ, SP. N.

In general aspect and body proportions it resembles E. duriculus, from which it differs in the following characters.

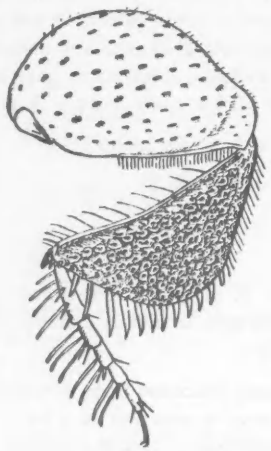
Very large for the genus, spindle-shaped, browish black, without metallic luster; antennae, tibiae and tarsi reddish brown, lateral margins of elytra with reddish color shining through. Frons and clypeus with very coarse and dense puncturation, without transverse rugosity, frontal carina weakly developed in center, eyes very flat. Pronotum very coarsely and densely punctate, punctures on sides and base fusing to form furrows; pronotal epipleura with short yellow setae. Dorsal striae on elytra shallow and indistinct; elytral disk with very dense and coarse rugose puncturation, which becomes a little less dense and finer on the sides and particularly on the humeral tubercle. Pygidium very coarse, with rasp-like puncturation.Prothoracic carina concave in profile, with erect hairs. Mesothorax, metathorax, 1st abdominal sternite and hindmargins of remaining sternites with distinct and rather dense punctures. Foretibiae with 4 denticles, 3 distal long and sharp (2nd is longest); the 4th, proximal, very short and blunt. Hindfemora very stout, their surface invested with deep but sparse punctures. Hindtibiae twice as long as broad, very strongly dilated and thickened in center, their outer surface covered completely with short spinules, and the inner surface with yellow hairs. Length 5.3 mm, with pygidium 6.1 mm, width 3.0 mm.

Southeast Turkmenia, Badkhyz, 12 km west of Kalai-Mor, sandhills, Mar.31,1957 (G. S. Medvedev). 1 specimen (holotype) in collection of Zoological Institute AN SSSR in Leningrad.

The species was named after E. N. Pavlovskii, who has done so much for the study of the insect fauna of Central Asia, in honor of his 75th anniversary.

All the representatives of the genus Exaesiopus are sand dwellers inhabiting the Mediterranean region, western and central Asia as far east as Kazakhstan. The type of the genus – E. grossipes (Mars.) – is found on the sandy shores of seas and rivers, while the remaining species inhabit sandy steppes and deserts. The discovery of a morphologically highly specialized representative of this genus in one of the most interesting desert regions of our country (Badkhyz) once again confirms the role of the deserts of Central Asia as a very important center for the development of new forms.

Peyerimhoff (1936)and A. N. Reikhardt (1941) have already noted that E. duriculus (Reitt.) differs from the other species of the genus Exaesiopus in the simply punctured frons without transverse rugosity and hence should perhaps merit separation. The species described above possesses the same character and hence should be assigned along with E. duriculus to a newly erected subgenus:



Hindleg of Exaesiopus (Reichardtiolus) pavlovskii O. Kryzhanovskij, sp. n.

Reichardtiolus O. Kryzhanovskij, subgen. nov. (gen Exaesiopus Rchdt., (1926).

Frons with simple, very coarse and dense puncturation, without transverse rugosity. 3 distal denticles of foretibiae very long, fine, with sharp points. Surface of hindfemora with distinct puncturation, outer surface of hindtibiae invested with short spinules. Remaining characters as in Exaesiopus s. str.

The subgenus includes 2 species, of which Exaesiopus (Reichardtiolus) duriculus (Reitt.) is recorded from Kazakhstan, Central Asia and Iran, while E. (R.) pavlovskii, sp. n. has been found so far only in Badkhyz.

The type of the subgenus is Saprinus duriculus Reitter, 1904.

The subgenus is named after the late A. N. Reikhardt – an outstanding Soviet coleopterologist–the greatest authority on the palaearctic Saprininae.

SUMMARY

During the recent expeditions in Turkmenian SSR, organized by the Zoological Institute, Academy of Science of the USSR, an interesting new psammophilous species of Histeridae was found and described under the name Exaesiopus pavlovskii O. Kryzhanovskij, sp. n. It is very similar to E. duriculus (Reitt.) but differs in much greater size (long 5.3, with pygidium 6.1, lat. 3.0 mm), uniformly brownish black color of the upper surface without any metallic tinge and extremely dense and coarse puncturing of the upper surface of the body.

Holotype (1 specimen from Badkhyz in southeastern Turkmenia, sandy desert, 30 March 1957, G. Medvedev leg.) is in the collection of the Zoological Institute, Leningrad.

Named in the honor of the eminent Soviet zoologist, academician E. N. Pavlovskii.

Both E. duriculus (Reitt.) and E. pavlovskii, sp. n., differ from the other species of Exaesiopus in densely punctured fronswithout transversal winkles, three very long and acute distal teeth of the front tibiae, clearly punctured surface of the hindfemora, and densely covered by the short spines outer surface of the hindtibiae. These two species are to be placed in a distinct subgenus Reichardtiolus O. Kryzhanovskij, subgen. nov. Typus subgeneris – Saprinus duriculus Reitt., 1904.

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THE GENUS APHALERIA RTT. (COLEOPTERA, TENEBRIONIDAE) AND ITS POSITION IN THE SYSTEM

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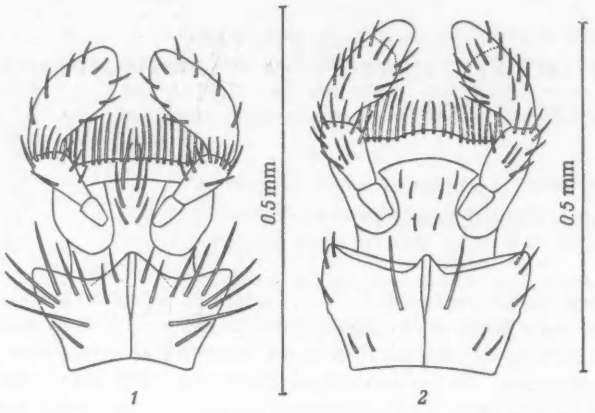
The genus Aphaleria Rtt. is represented by a single species A. pygmaea Fisch.-W., which is known from the deserts of Turkmenia and Uzbekistan. Ecologically it is associated with sandy soils, being found under damp sand, and it is not until spring, after the rains, that it occurs on the surface itself, under the leaves of such plants as Rheum turkestanum. Fischer de Waldheim (1821: 12; 1823-1824: 195) erroneously assigned this tenebrionid to the genus Erodius, which is now included in the tribe Erodiini, and to many forms of which (the genera Arthrodosis, Ammozoum etc.) the above species bears a purely superficial resemblance.

Reitter (1896: 235-236) described this species anew as a representative of a new genus Aphaleria of the subfamily Trachyscelinae. Judging from his description and entire figure, he had at his disposal only females, in which the 2nd and 3rd segments of the fore-and middle tarsi, as distinct from the males, are not dilated. In his keys published later (1904: 171) this author included the genus Aphaleria in the subfamily Opatrinae of the tribe Opatrini. In a review of the palaearctic Opatrini, Reikhardt (1936: 173-174) established the synonymy of the species but apparently did not reinvestigate its position in the system and left it in this tribe. At the same time the morphological characters indicate that Aphaleria pygmaea Fisch.-W. definitely belongs to the tribe Pedinini, to which it must be assigned on the basis of the structure of the male fore-and middle tarsi, the 2nd and 3rd segments of which are dilated and bear a tuft of hairs on the underside. From the evolutionary viewpoint great interest as attached to the similarity between the sand-dwelling Aphaleria and the polytypic genus Dissonomus, which is associated with compact soils. In particular, a study of the oral apparatus shows that it is of the same type in both genera. Especially characteristic is the labium (Figs. 1 and 2), in the structure of which we should notice particularly the very similar form of the mentum, which bears a ventral keel with a very characteristic outline. In the structural features of the labium both genera differ markedly from other palaearctic Pedinini. A very thorough comparison indicates that this similarity is due to a common origin. The structure of the other mouthparts also confirms the close relationship of these two genera. The presence of stronger setae on the submentum in Aphaleria must be related to the fact that the whole ventral surface of the body, particularly the prothorax and elytral epipleura, is densely invested with hairs and setae. The dorsum, as in Dissonomus, is smooth and completely devoid of hair covering. A similar distribution of the hair covering is found in certain other sand-dwelling tenebrionids of similar aspect (Weisea of the Opatrini). At the same time, we should note the depigmentation of the integument in Aphaleria, a feature almost exclusively confined among the tenebrionids to the sand-dwelling (Habrobates, Argyrophana, Arthrodosis, Ammozoum, Alcinoe, Dengitha) and myrmecophilous (Platamodes, Oogaster, Reitterella) forms.

In comparison with Dissonomus the head capsule of Aphaleria differs in the relatively weak development of the eye prominences and the deeper incision of the clypeus. Nevertheless, the form of the head in both species is very alike, as also is the position of the eyes, which are not divided into two parts by extensions of the genae. Most of the other tenebrionids of the subtribe Pedinini, which includes Aphaleria and Dissonomus, have divided eyes, with the exception of certain winged forms (Dilanus).

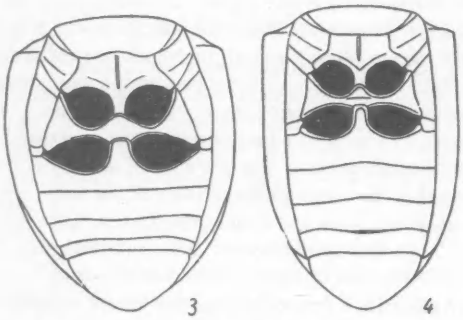
In the structure of the pronotum we should note that along the entire basal margin in both species there is a plate-like protuberance which overlaps the articulation of the prothorax and mesothorax. Very characteristic, also, is the prothoracic process which rises high over the epimera behind the coxae.

The structure of the mesothorax, metathorax and elytral epipleura (Figs. 3-4) also confirm the close relationship of the investigated species. For instance, the narrow bridge-like form of the metathorax between the coxae indicates the great antiquity of the loss of flying ability. The degree of reduction of the first four visible abdominal sternites in Aphaleria is due to adaptative processes and finds analogs among many of the sand-dwelling tenebrionids (Arthrodosis, Weisea).

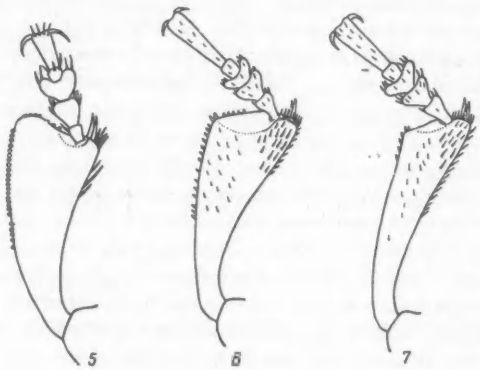


Figs. 1-2. Labium from below. 1) Aphaleria pygmaea Fisch.-W.; 2) Dissonomus tibialis Duval.

The adaptative nature of the morphological features in relation to dwelling in sandy deserts is clearly expressed in the structure of the legs in Aphaleria. The front pair of legs with the dilated and flattened tibia (Fig. 5) constitutes a tool for digging in the sand. The very fine serration on the outer margin consists of reduced and flattened spinules, homologous to those in Dissonomus (Figs. 6, 7), but stouter and shorter. It is of



Figs. 3-4. Underside of body. 3) Aphaleria pygmaea Fisch.-W.; 4) Dissonomus tibialis Duval.

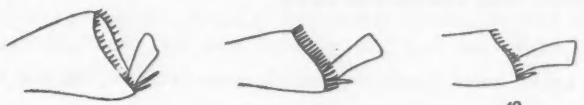


Figs. 5-7. Left foretibiae from above. 5) Aphaleria pygmaea Fisch.-W; 6) Dissonomus angustitarsis Rtt.; 7) D. tibialis Duval.

interest that the spinules have not been lost and it is probable that in conjunction with the two large spurs situated at the base of the tarsus they assist digging in the sand. There is no doubt about the functional significance of the areas on the distal ends of the hindtibiae (Fig. 8), which serve to push aside the soil particles. This marked specialization of the legs in Aphaleria, conditioned by life in sand, is a unique case among the Pedinini (Figs. 9, 10).

Besides species with narrow foretibiae (Fig. 7) the genus Dissonomus includes species in which their form approximates those of Aphaleria. As an example we may cite D. angustitarsis Rtt. (Fig. 6), which occurs on loess soils, mainly in the cast-up heaps of loose soil near the burrows of Lethrus. In Dissonomus, however, the outer angle is always much weaker.

Results of a morphological analysis show that the genus Aphaleria in the system Pedinini is very close to the genus Dissonomus, and differs from the latter in several characters of an adaptative nature associated with dwelling in sand. Apparently both species had a common initial form, one branch of which (genus Dissonomus) developed on compact soils where, in accordance with the diversity of soil conditions and the special features of the mode of life, there took place a considerable divergence in development, leading to the formation of a considerable number of species, which differed most markedly in the structure of the legs. In Central Asia the genus Dissonomus is represented by 7 out of the 11 known species. The other branch gave rise to a highly specialized psammophilous form – Aphaleria pygmaea Fisch.-W.



Figs. 8-10. Apex of left hindtibiae. 8) Aphaleria pygmaea Fisch.-W.; 9) Dissonomus angustitarsis Rtt.; 10) D. tibialis Duval.

The specific conditions of life under sand occasioned the development in Aphaleria of a distinctive ecological-morphological type, the characteristic features of which are the highly convex body form, the strong, but not long, legs with fossorial foretibiae, the expanded areas on the distal ends of the hindtibiae, winglessness and depigmentation. Extreme representatives of such specialization are, for instance, species of the genus Philothis (Coleoptera, Histeridae) or Stibaropus (Heteroptera, Cydnidae).

SUMMARY

The genus Aphaleria, previously assigned to the tribe Opatrini should be placed in the tribe Pedinini, because the 2nd and 3rd segments of the fore-and middle tarsi of male Aphaleria are dilated. A morphological analysis shows that the only species of this genus – A. pygmaea Fisch.-W. – is very closely related to the genus Dissonomus and differs from the latter in adaptative characters related to life in sand.

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ADAPTIVE COLORATION IN MOTHS AND CATERPILLARS OF CELERIO VESPERTILIO ESP. (LEPIDOPTERA, SPHINGIDAE)

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Sukhumi Essential-Oil Plant Experimental Station

Mimicry is widely known among members of various orders of insects, but it is particularly diverse among the Lepidoptera.

The adult insects and their larval and pupal phases often imitate various objects among which they dwell. In the majority of cases even the most variable larval phase imitates some particular object during its whole life, but we do occasionally observe the imitation of different objects at different instars.

A well-known insect is the remarkable caterpillar of the alder noctuid Acronicta alni L., which in early life resembles a bird's dropping lying on the upperside of a leaf, while the full-grown caterpillar is colored black with bright yellow transverse stripes and has long hairs with swollen tips.

The young caterpillar of Aglia tau L., which is adorned with complex spines, becomes smooth in the full-grown state and resembles a rolled leaf.

Yet such examples are comparatively few. Hence the Celerio vespertilio caterpillar which I observed is of undoubted interest, the moths of this species being rather rare and being associated with a particular vegetation and habitat.

In the USSR this sphinx moth is known only from a few localities in Transcaucasia. In western Europe it is found in Italy, France and West Germany.

Belonging to a widely distributed genus Celerio (Deilephila), it is clearly distinguished from the other representatives by the bluish grey coloration of the forewings, which in other species of this genus are brownish with typical broad banding.

Caterpillars of most species of the genus Celerio are brightly colored, usually live on spurges (Euphorbia) and bedstraws (Galium), and feed by day. They are distinguished by an unpleasant taste; thus, the bright coloration of the young and fully grown caterpillars is a warning, as it were, to insect-eating animals of the unsuitability of the caterpillars as food.

The caterpillar of C. vespertilio, like the moth, differs distinctly from other related species; the effect of the special features of the environment in which the insect lives has led to the elaboration of a different coloration and different behavior.

Celerio vespertilio lives on a plant specific to our river pebble-beds - Chamaenerium angustissimum Gr., which in systematic relation is closely related to the willow-herb (Ch. angustifolium L.) but differs from it in a number of characters and in its xerophytic nature.

The moth emerges from the overwintered pupae in June and shortly after lays its eggs on the narrow leaves of the plant. The number on one plant usually varies from 2 to 10.

The caterpillars which emerge from the eggs are green in color, without markings, and as distinct from the vast majority of sphinx moth larvae, in particular from all our species of the genus Celerio, they are com-

pletely devoid of the horn which is characteristic of the members of this family. The young caterpillars feed during the day and, when alarmed, they lie stretched out along the leaf, which they resemble in shape and coloring. The young caterpillars never leave the plant, and lead the same mode of life up to the 4th (penultimate) instar.

Then an interesting metamorphosis takes place. After the next molt the caterpillars become dark grey, with a series of pinkish yellow spots arranged along the body, and a pale stripe above the legs; there is no horn. In the 5th instar the caterpillar is paler, and the spots are pale yellow or slightly pinkish.

Its mode of life changes. The fully grown caterpillars feed only at night, and by day they hide among the small stones, between which they lie curled up, in excellent imitation of a pebble. Sometimes the caterpillars hide in cracks in the stones. At twilight they crawl on to the plant and feed until dawn, when they descend to the ground.

The caterpillars live for about 3 weeks, and then pupate in the sand among the pebbles.

The majority of species of the genus Celerio produce a second brood, but since more than 75% of the pupae of C. vespertilio overwinter, moths emerge in September from only some of them. Yet we never managed to find the caterpillars of the second brood.

The coloration of the forewings of the moth resembles the grey stones and boulders among which it usually rests by day. Wing marking are generally absent but in a few individuals they are vaguely outlined.

Thus, as a result of the change of habitat not only the coloration of the insect, but the behavior of its caterpillars, has been altered.

It is of interest to note that C. vespertilio can easily be crossed with other species of the genus Celerio, the hybrid caterpillars often having a reduced horn and dark coloration.

NEW EAST ASIAN SPECIES OF THE GENERA DUFOUREA AND HALICTOIDES (HYMENOPTERA, HALICTIDAE)

V. V. Popov

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This paper is devoted to the controversial question of the generic independence of Dufourea and Halictoides, to the question of the subgeneric groupings of the latter, and to a description of five new species. Their types are preserved in the Zoological Institute AN SSSR.

DUFOUREA LEP.

The hypothesis of the generic identity of Dufourea and Halictoides has been put forward more than once (Vachal, 1897; Friese, 1901). Timberlake (1939) also concluded that they were systematically united from a study of the female copulatory organs and adjacent sternites of both genera and their complete similarity. This view was supported by Michener (1944, 1951). Unfortunately, Timberlake did not publish a single drawing of the copulatory organs nor did he give a single description of them, except for one of the three American species of Dufourea – D. leachi Timberl., in which he pointed out several characteristic features of its copulatory organs.

Timberlake states that if we place Dufourea on that "broad and conservative basis", on which the genera Nomia, Halictus, Andrena and Megachile (s.l.) stand, it is not only logical but necessary to merge Halictoides and its numerous subgenera with Dufourea. Here Timberlake gives a list of genera, the systematics of which require serious reexamination from the generic and subgeneric aspect, a point on which all investigators agree. Michener (1944), for instance, refers to the controversial nature of Nomia. He attempted to divide Halictus into a number of independent genera, as other authors, notably Robertson, had tried to do prior to this. But even if we leave aside this position, it should be noted that the copulatory organs of Dufourea and Halictoides are not identical, but show several important differences; differences in the external characters of the females have also been noted. Thus, the view that these "subgenera" differ only in a few characters in the males, is not corrected. Nor is it correct to maintain that Halictoides cannot be divided into several subgenera. Michener correctly noted that "the subgenus Halictoides still contains very different elements" (p. 252).

Dufourea and Halictoides are two closely related genera divisible into several subgenera and groups of species, each of which has undergone a prolonged and distinctive evolution. The group of genera closely related to Dufourea also includes Trilia Vach. and Morawitzella Popov; the Halictoides genus group includes Mimulapsis Bridwell, Micralictoides Timberl. and, probably, Conanthalictus Ckll. The first group, with the exception of three nearctic species of Dufourea, are inhabitants of the Palaearctic region. The second, with the exception of the holarctic (much more richly represented in the nearctic) genus Halictoides, are inhabitants of the nearctic region. They also differ in their oligotrophic relations with flowering plants, but this question will be examined elsewhere.

Dufourea and Halictoides differ in the following characters:

1 (2). Antennae of females lacking tyloids; spurs of middle legs normal, with weak comb and sharp apex; lowering basal vein (cu-v) usually falls in before upper basal (M). Antennae of males usually shorter than trunk; 6th sternite usually simple; 7th tergite with pygidium-like area on apex; gonostyles of copulatory organ slender, round in cross section, separated from gonocoxites; volsellae broad, flat, rigidly united with gonocoxites . . . . . Dufourea Lep.

2 (1). Antennae of females with tyloids; spurs of middle legs flattened, with strong comb and characteristic flattened hook on the blunt apex; lower basal vien (cu-v) usually interstitial with upper basal (M). Antennae of males usually longer than trunk; 6th sternite modified, with callus-like processes or apical projection; 7th tergite rounded at apex, without pygidium-like area; gonostyles of copulatory organ broader, oval in cross section, not separated from gonocoxites or separated from them only dorsally; volsellae slender, long, articulated with gonocoxites . . . . . Halictoides Nyl.

DUFOUREA ARMATA POPOV, SP. N.

♂. Length 5 mm. Head rather flat, as broad as long, angularly expanded on sides of vertex, where distance from apex of eye to margin of vertex is approximately equal to greatest width of eye. Temples developed only at upper half of eyes, equal to their width. Eyes almost twice as long as their greatest width, roundly angulate on outer margin, strongly converging on their inner margin. Distance between lateral and median ocelli equal to its diameter; distance between lateral ocelli and margin of vertex almost equal to twice their diameter. Labrum oval rather convex, but flattened in middle, twice as broad as long, equal in length to clypeus. Clypeus three times as broad as long, with straight foremargin. Distance from antennal pits to margin of clypeus almost twice diameter of pits. Scape of antenna rather stout, straight, three times as long as its greatest width at apex; 1st segment of flagellum almost equal in length and breadth, spherical; 2nd almost 1 1/3 times as long as broad; 3rd almost twice as long as broad; the succeeding segments, gradually thickening, almost 1 1/2 times as long as broad, convex (the apical segments of the antennae were broken off). Horizontal part of intermediate segment inclined, equal in length to the scutellum and metanotum together. Abdomen narrow, elongate. Apical parts of tergites noticeably impressed, equal to 1/5-1/4 length of tergite, not converging at sides. 6th sternite (Fig. 1,a) large, produced in middle at apex and bearing there a small area, projecting beyond margin of sternite, roundly angulate on sides and with a stout flat tooth in the middle. 7th tergite (Fig. 1,b) with strongly projecting undemarcated, distinct pygidium-like apex. Seventh sternite (Fig. 1,c) with long, narrow basal lobes (an incomplete preparation); apical lobes curved, flat, weakly chitinized, not constricted at base and not separated from basal lobes, angularly dilated dorsally and ventrally at the free end, with long, intricately branched hairs in the apical half. Eighth sternite (Fig. 1, d) with characteristic angulated basal lobes divided by a broad median notch, twice as deep as wide; lateral lobes produced back at an angle, sharp; apical part narrow, long, straight, hardly widened in middle, with sparse and uneven hairs. Gonobase of copulatory organ (Fig. 1, e) almost three times as broad as long dorsally. Gonocoxites twice as long as greatest width at base, converging rapidly to a rounded apex, slightly emarginate on outer side and strongly so on inner. Gonostyles very slender, round in cross section, weakly bent and noticeably constricted at base, with sparse, short hairs. Volsellae (Fig. 1,f) rather flat, with one free segment, three times as long as greatest width, with rather long hairs; at base of volsella, in the gonocoxite wall, lies a more chitinized round area, which is probably the remnant of the basal segment of the volsella. Sagitta slightly dilated and weakly bent dorsoventrally, with long and narrow apices, with a small angular projection in the middle, ventrally; basal lobes straight, rather slender. Penis fairly broad, with sclerotized areas on sides at base.

Shining. Head densely punctate; on clypeus, face and vertex the puncturation is very dense, almost recticular, the punctures lying directly or almost directly against one another; puncturation of supraclypeal area, the adjacent lateral portions of face and small areas near the lateral ocelli very sparse, fine; these areas strongly shining, completely devoid of punctures in parts. Pronotum with indistinct, dense pucturation, shagreened, mat. Mesonotum with denser puncturation on periphery where interspaces between punctures are much less than their diameter, and with rarer, irregular, punctures arranged in rows in the remaining parts, the rows being one to several puncture-widths apart. Puncturation of scutellum sparser. Sides of trunk with indistinct rather dense puncturation. Intermediate segment densely shagreened, mat; central area partially striately shagreened, clearly delimited on sides. Basal areas of tergites finely shagreened, finely and evenly punctate, interspaces between punctures being 1-2 times their diameter, punctures irregular. Sternites shagreened, with fine, sparse puncturation.

Metallic-green, suffused with bluish on the head, sides of trunk and median segment, abdomen darker. Mandibles, labrum and legs dark, tips of mandibles reddish. Antennae, particularly the flagellum, brown. Humeral swellings brownish, tegulae reddish brown, veins of transparent wings pale yellowish red, subcosta dark. Apical parts of tergites pale brown, sternites brown, Spurs yellowish white.

Body invested with sparse, erect, rather long grey or yellowish grey hairs; hairs on clypeus long, dense, pendant. Pubescence on abdomen short, sparse, appressed, longer on sides.

♀ not known.

China, R. Bomyn (Ichegin), N. Tsaidam, Gobi, June, 1895, 1 (V. Roborovskii and P. Kozlov).

According to the descrpition, this species is close to D. versicolor Alfk., known from a female from south Kansu, but differs distinctly from it in the broad, not elongate head, short clypeus, mat intermediate segment, and in coloration.

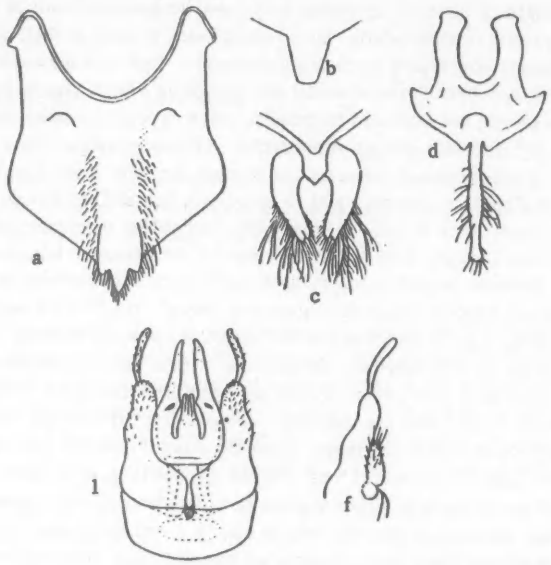

Fig. 1. Dufourea armata Popov, sp. n. ♂. a) 6th sternite; b) 7th tergite; c) 7th sternite; d) 8th sternite; e) copulatory organ, dorsal view; f) volsella.

HALICTOIDES NYL.

Friese (1909) divided the palaearctic species into two groups on the basis of the black or metallic coloration of their representatives. Cockerell (1924) established for the first species of the second group – H. paradoxus F. Mor. – the subgenus Cephalictoides, on the basis of the ratio of the length of the individual segments and structural details of the maxillary palps, the structure of which he considered of great significance. Later, this subgenus was considered along with the others as a generic synonym (Timberlake, 1939; Michener, 1944), which is hardly correct. Michener, as mentioned earlier, rightly stated that Halictoides still contains various elements.

The groups proposed by Friese are considered here as subgenera on the basis of several other, hitherto unknown, characters:

1 (2). Black, without metallic luster. Head with uniform dense reticulate puncturation, usually coarse. Second segment of flagellum in male much shorter than 3rd, scarcely broader than long. Fourth sternite with oblique keels along sides, sometimes fused with one another, without a callus-like ridge in center. Sixth sternite not produced, with callus-like processes in center before foremargin. Gonostyles slender, long, not or just separated dorsally from gonocoxites . . . . . Subgenus Halictoides Nyl.

2 (1). Head and sometimes pronotum, median segment and abdomen with metallic luster. Head with irregular, shallow puncturation, usually the vertex and temples shining, with sparser puncturation. Second seg-

ment of flagellum of male equal to 3rd or much longer than broad. Fourth sternite without oblique keels on sides, sometimes with a round callus-like ridge covered with forward-pointing seta-like hairs. Sixth sternite produced at apex into a large median protuberance or long sharp process, slightly thickened in middle. Gonostyles broader, usually distinctly separated dorsally from gonocoxites .... Subgenus Cephalictoides Ckll.

Of the total of 14 palaearctic species known at the present time, 6 belong to the subgenus Halictoides: H. dentiventris Nyl. 1848, H. schmiedeknechti Kohl 1906, H. merceti Vach. 1907, H. mongolicus, sp. n., H. carinatus, sp. n.

To the subgenus Cephalictoides belong: H. paradoxus F. Mor. 1867 (type of subgenus), H. atrocoerulus F. Mor. 1876, H. pamirensis F. Mor. 1893, H. calcaratus F. Mor. 1886, H. clavicrus F. Mor. 1890, H. montanus F. Mor. 1890, H. spiniventris, sp. n., H. mandibularis, sp. n.

HALICTOIDES (HALICTOIDES) MONGOLICUS POPOV, SP. N.

♂. Length 6-7 mm. Head (Fig. 2,a) rather flat, almost equally broad and long, rounded on vertex, where distance from apex of eye to margin of vertex is a little less than greatest width of eye. Temples developed only at upper half of eyes, a little less than their width. Eyes almost twice as long as their greatest width, with rounded angles on outer margin, noticeably converging on inner margin. Distance between lateral and median ocelli less than their diameter, distance between lateral ocelli and margin of vertex approximately equal to three of their diameters. Labrum oval, rather convex, but flattened centrally, twice as broad as long, almost equal to length of clypeus. Mandibles long, bent, with two teeth. Maxillary palps 6-segmented, long, first two thickened, equal to length of other four. Labial palps 4-segmented, shorter. Clypeus twice as broad as long, with straight foremargin. Distance from antennal pits to margin of clypeus equal to their diameter. Scape of antenna (Fig. 2, b) rather thick, almost straight, three times as long as greatest width at apex; 1st flagellar segment almost equally broad and long, spherical; 2nd appreciably shorter than broad; 3rd three times as long as broad; 4th and all subsequent segment 2 1/4 times as long as broad, slightly thickened at apices, with large tyloids occupying almost the whole length of the segments; 11th flagellar segment scarcely longer. Horizontal part of intermediate segment short, equal to length of scutellum. Abdomen rather narrow, produced. Apical parts of tergites noteceably impressed, equal to 2/5-1/2 length of tergite, noticeably converging on sides. Seventh tergite round at apex, without pygidium-like process. Fourth sternite distinctly constricted almost through its entire breadth. Fifth sternite much longer, with obliquely incised short portions on sides, forming distinct keels on hindmargin. Sixth sternite strongly and broadly produced on hindmargin and bearing a small callus-like process in center at apex. Seventh sternite (Fig. 2,c) with long and narrow basal lobes, angularly expanded at free end; apical lobes long and narrow, flat, very roundly convex only in central part, forming small additional lobes; these lobes delimit circular cavities open at the sides; apical lobes in free half invested on outside with rather short, dense hairs. Eighth sternite (Fig. 2, f) with characteristic strong, angulate basal lobes divided by a broad median notch, twice as deep as broad; lateral lobes small, produced back at an angle; apical part narrow, long, weakly curved ventrally, barely converging before rounded free end, with sparse and uneven hairs. Gonobase of copulatory organ (Fig. 2, e) almost three times as broad as long dorsally. Gonocoxites twice as long as their greatest width at base, strongly converging to an appreciably expanded apical part, round on outer margin and slightly angulate on inner; apical part covered dorsally with dense plumose hairs. Gonostyles rather slender, weakly bent, not separated from gonocoxites, oval in cross section, converging to a slightly pointed apex, bearing solitary hairs. Volsellae (Fig. 2, f) one-segmented, long, very slender, with short hairs, and noticeably dilated at base, which lies freely in the membrane at the base of the gonocoxites. Sagittae appreciably expanded, slightly bent dorsoventrally, with a small tooth in the center of the inner margin and with long narrow apices; basal lobes almost straight, slender. Penis broad, with sclerotized areas on sides at base.

Weakly shining. Head densely punctate, punctures almost contiguous, forming a reticular sculpture in places, or the distance between them does not exceed 1/2-1 diameter. Puncturation of pronotum indistinct. Mesonotum and scutellum with rather coarse and uniform puncturation, the interspaces between punctures obviously less than their diameter, but in center the punctures are somewhat rarer, and the interspaces greater than their diameter. Intermediate segment densely punctate and shagreened, mat; central area longitudinally striate-costate, shagreened, distinctly demarcated at sides. Basal parts of tergites shining, with coarse, unevenly scattered punctures, the interspaces being 1/2 to several times their diameter. Apical parts very shining, not punctate. Sternites mat, rather finely and densely punctured.

Blackish brown. Tips of mandibles reddish. Antennae brown, tyloids yellowish, as also wing veins; subcosta and lower margin of pterostigma darker. Tegulae and sometimes tarsal segments brown or reddish brown. Spurs pale yellow. Apical parts of tergites broadly, and sternites narrowly, yellow, transparent, apical sternites reddish.

Body with relatively dense, long, erect grey hairs, denser on clypeus and face. Abdominal tergites with apical crossbands of long, sparse, semirecumbent hairs.

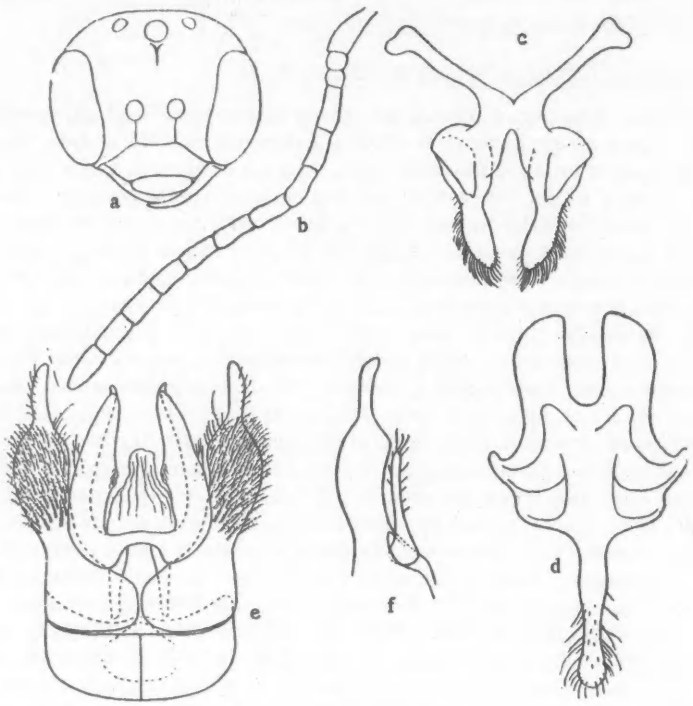

Fig. 2. Halictoides (Halictoides) mongolicus Popov, sp. n. ♂. a) Head from front; b) antenna; c) 7th sternite; d) 8th sternite; e) copulatory organ, dorsal view; f) volsella.

♀ not known.

Mongolia, western foothills of Ikhé Bogdo, Gobi Altai, Aug. 17-21, 1926. 4 ♂♂ (A. Kirichenko).

This species is relatively close to H. inermis Nyl., but differs distinctly in the structure of the antennae with well-developed tyloids, the shorter keels on 5th sternite, the structure of 6th sternite, the narrower and longer apical lobes of 7th sternite and its structural details, the longer and broader gonostyles, details of the puncturation, etc.

HALICTOIDES (HALICTOIDES) CARINATUS POPOV, SP. N.

♀. Length 7-8 mm. Head (Fig. 3,a) noticeably broader than long, broadly round at vertex, rather flat, with barely projecting clypeus. Distance from apex of eye to margin of vertex equal to half the greatest width

of the eye. Temples developed only at upper part of eyes, almost equal to their width. Eyes round on outer margin, almost straight and parallel to one another or inner margin. Distance between lateral and median ocelli almost equal to diameter or latter, distance between lateral ocelli and margin of vertex equal to twice their diameter. Labrum oval, almost flat, three times as broad as long, appreciably shorter than clypeus. Mandibles rather long, narrow, weakly bent, with two teeth at apex. Maxillary palps 6-segmented, rather long, the two basal segments obviously thickened and only a little elongate as compared with others, equal to one another. Labial palps 4-segmented, shorter, slender; basal segment long, equal to the other three together; 2nd very short, only twice as long as broad. Proboscis short, shorter than length of praementum. Clypeus three times as broad as long with almost straight fore margin. Distance from antennal pits to margin of clypeus scarcely greater than their diameter. Scape of antenna (Fig. 3, b) slender, bent, more than 4 times longer than its greatest width at apex; 1st flagellar segment 1 1/2 times as long as broad, spherical; all the succeeding segments, which gradually thicken at first, are much shorter than broad, the terminal segment appreciably longer than broad, segments 6-10 with small tyloids. Face from base, and almost to middle, distinctly angularly impressed and bearing a stout convex longitudinal keel, which becomes broader and higher toward base of antennae and then merges with the raised base of the supraclypeal area. The horizontal part of the intermediate segment is long, almost equal to length of scutellum, angulate. Abdomen broad, flattened. Apical parts of tergites weakly impressed, equal to 2/5 length of tergite, narrower at sides, where basal part is more convex.

Weakly shining. Head coarsely punctured, punctures on face and vertex are either contiguous, forming a reticulate sculpture in parts, or the interspaces between them may be as great as their diameter. Puncturation of shining sides and lower part of face much sparser. Clypeus with coarse punctures, partially rasp-like, almost contiguous on periphery, sparser in center. Supraclypeal area finely and densely punctate, centrally with a longitudinal impunctate shining stripe. Puncturation of mesonotum and scutellum finer than puncturation of head, dense, regular, interspaces rarely exceed 1/2-1 diameter, usually smaller. Puncturation on sides of body dense, almost as on pronotum, sometimes finer, obscure. Intermediate segment densely shagreened on sides, with a few indistinct punctures, uniformly and densely punctured in remaining parts. Central area of median segment densely and finely ribbed. Basal parts of tergites evenly punctured, interspaces between the irregular rows of punctures much greater than their diameter. Apical parts very finely shagreened, shining. Sternites densely shagreened, with rather dense puncturation.

Black. Tegulae, veins of transparent wings, apical parts of tergites and spurs yellowish brown, base of spurs pale yellow.

Body with rather dense and long light ochreous hairs. An admixture of shorter dark hairs on face and vertex. Pubescence of tergites short, series of rather sparse and long hairs before apical part of tergites. Anal fringe brownish gold. Some of the hairs on inner side of legs dark. Base of 2nd-5th tergites with narrow cross-bands of short recumbent white hairs.

♂. Length 7.5 mm. Similar to female. Head (Fig. 3,c) a little shorter than in female. Eyes broader, converging a little toward clypeus. Clypeus almost four times as broad as long, almost equal to length of labrum. Scape of antenna (Fig. 3,d) rather stout, three times as long as greatest width at apex; 1st flagellar segment equally broad and long, round; 2nd barely shorter than broad; 3rd-9th slender, three times as long as broad, all subsequent ones stout, more than twice as long as broad, swollen, apical segment almost three times as long as broad; segment, beginning from 5th, with small tyloids, which gradually become larger and are equal to more than 1/3 of the length of the 10th segment. Face from base of antennae to center deeply impressed, with a large and stout, narrower than in female, longitudinal keel. Abdomen narrow, long, slightly flattened. Seventh tergite long, broadly rounded on produced apex. Fifth sternite with long oblique keels on sides, projecting at an angle on foremargin and with two callus-like thickenings in the center of the produced foremargin Sixth sternite large, broadly rounded on apical margin, with two large angulate calluses in center in upper third and one weaker, produced at center of foremargin. Seventh sternite (Fig. 3,e) with long and narrow basal lobes, angularly expanded at free end; apical lobes rather long, straight and parallel to one another, very swollen, angularly expanded at base on outer side, slightly emarginate before apex on inner side, with sparse and rather short hairs in apical half. Eighth sternite (Fig. 3, f) with characteristic, stout, roundly angulate basal lobes, divided by a long narrow notch, four times as deep as its greatest width; lateral lobes small, roundly angulate, produced backwards a little; apical part narrow, long, slightly bent ventrally, with rather dense and long hairs. Gonobase of copulatory organ (Fig. 3, g) almost three times as long dorsally. Gonocoxites twice as long

as their greatest width at base, strongly converging to a slightly dilated apical part, weakly rounded on outer margin and barely angulate on inner; apical part covered dorsally with rather dense, very short hairs. Gonostyles slender, long, curved, scarcely noticeably separated from gonocoxites dorsally, almost round in cross section, pointed at free end. Volsellae (Fig. 3,h) one-segmented, very slender, with short hairs, appreciably expanded at base, which is almost fused to gonocoxites. Sagittae noticeably expanded, weakly bent dorsoventrally, but strongly angularly produced at base, with small tooth on inner margin and with long, narrow apices; basal lobes almost straight, slender. Penis broad, with sclerotized areas on sides at base.

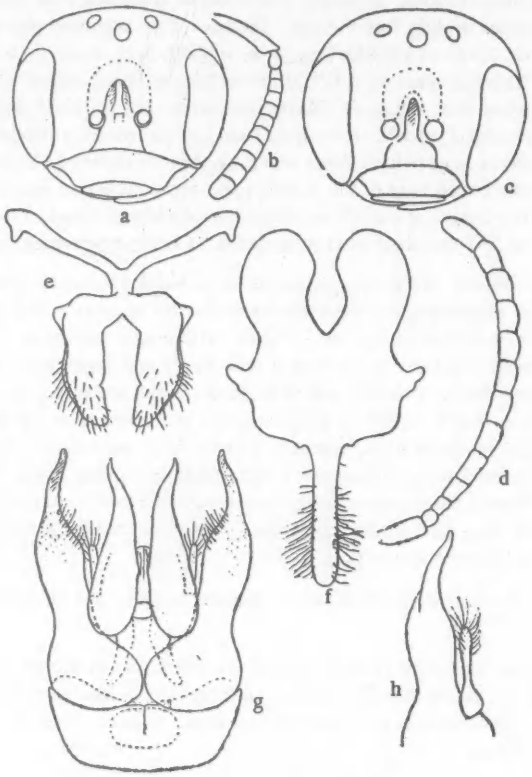

Fig. 3. Halictoides (Halictoides) carinatus Popov, sp. n., ♀ ♂. a) Head of females from front; b) antenna of female; c) head of male from front; d) 7th sternite of male; e) 8th sternite of male; f) copulatory organ of male, dorsal view; g) volsella.

Weakly shining. Head very coarsely and reticularly punctate, punctures contiguous, but on vertex and temples the puncturation is sparser and the shining interspaces between the punctures reach 1/4-1/2 of their diameter. Facial impression finely shagreened, shining, not punctate. Puncturation of mesonotum, scutellum and sides of trunk as in female. Sides of intermediate segment rugosely shagreened. Basal parts of tergites densely and coarsely punctate, interspaces between punctures much less than their diameter. Sternites finely shagreened, shining.

Black. Tips of mandibles reddish. Flagella brown ventrally. Tegulae, wing veins, apical parts of tergites yellowish brown. Spurs pale yellow. Body with rather dense yellowish grey hairs, which are shorter than in female.

Amur region, Amur district, Aug. 15-18, 1928, 1 ♀ (Tupitsyn); Mongolia, valley of R. Talyr, Khingan, June 19-21, 1899, 1 ♀ (V. Soldatov); valley of R. Syel'gzhi, Khingan, Aug. 22, 1899, 1 ♂ (V. Soldatov).

Close to H. inermis Nyl., but female differs distinctly in the strong, sharply demarcated keel on the face; the male, in addition, by the strong impression of the face; both sexes by the larger and sparser puncturation of the head; the male by the developed calluses on 5th sternite, 7th sternite with longer basal lobes and the narrower and longer notch between them, the 8th sternite with the shorter and bulkier apical lobes and the gonocoxites of the copulatory organ, which are devoid of dense hairs dorsally.

HALICTOIDES (CEPHALICTOIDES) SPINIVENTRIS POPOV, SP. N.

♂. Length 9.5-10.5 mm. Head (Fig. 4,a) rather flat, somewhat broader than long, weakly rounded on vertex and slightly angulate on sides. Distance from apex of eyes to margin of vertex almost equal to greatest width of eye. Temples developed only at upper half of eyes, slightly less than their width, round on outer margin, noticeably converging on inner. Distance between lateral and median ocelli equal to half diameter of latter, distance between lateral ocelli and margin of vertex equal to approximately two diameters. Labrum oval, rather convex, but flattened in middle, twice as broad as long, almost equal to length of clypeus. Mandibles rather long, weakly bent, with two teeth. Maxillary palps 6-segmented, rather long, all segments relatively slender, gradually tapering to apical segment, and all almost equal in length. Labial palps 4-segmented, shorter, apical segments shorter than basal. Proboscis short, much shorter than praementum, paraglossae well developed. Clypeus three times as broad as long, with almost straight foremargin. Distance from antennal pits to margin of clypeus equal to their diameter. Antennae very long, reaching 3rd segment of abdomen. Scape of antenna (Fig. 4,b) stout, noticeably bent, three times as long as greatest width at apex; 1st flagellar segment barely shorter than broad round; 2nd twice as long as broad; 3rd five times as long as broad; 4th and all subsequent four times as long as broad; 9-11th noticeably bent, slightly thickened before apex; 5-11th at base with small (no more than 1/4 of the length) tyloids, which increase in size (to 1/2 length) toward apical segments. Face from base of antennae to center noticeably impressed, with a large and stout longitudinal keel. Horizontal part of intermediate segment long, longer than scutellum, angulate. Abdomen rather narrow, but not greatly produced. Apical parts of tergites noticeably impressed, equal to 1/4 to 1/3 length of tergite, not converging at sides. Seventh tergite round at apex, without pygidium-like process. Third and 4th sternites with two small oblique callus-like processes, more strongly developed on 4th sternite. Fifth sternite broadly and roundly emarginate on apical margin, with an uneven transverse impression separating the lower basal part from the higher apical, and bearing two small tubercles in center of apical margin. Sixth sternite (Fig. 4, c) large, with a large, straight stout protuberance in center of apical margin, almost equal to length of sternite. Seventh sternite (Fig. 4,d) with rather broad and long basal lobes, angularly expanded in the free half; apical lobes long and narrow, thickened dorsoventrally, only the connecting basal part between them flat; apical lobes bearing ventrally in basal half a small tooth, apices of the lobes produced inwards and contiguous at free end. Eighth sternite (Fig. 4,e) with characteristic, stout, angulate basal lobes separated by a small and fairly narrow notch, 1 1/2 times longer than its width; lateral lobes small, with sharp, not backward-curved, angles; apical part narrow, long, weakly bent ventrally, obviously converging gradually before the round free end, with rather dense, long hairs. Gonobase of copulatory organ (Fig. 4,f) almost three times as broad as long dorsally, Gonocoxites twice as long as their greatest width at base, strongly converging to an appreciably expanded apical part, round on outer margin, almost straight on inner. Gonostyles rather broad and short, separated from gonocoxites, covered in places, as also the apex of the latter, with sparse and short hairs; apices of gonostyles sharp, bent slightly outwards. Volsellae (Fig. 4,g) one-segmented, long, very slender, with rather long hairs; apices and bases of volsellae n noticeably expanded, the latter lying almost free in base of gonocoxites. Sagittae strongly dilated, weakly bent dorsoventrally, with a small tooth on center of inner margin; apices of sagittae narrow, long basal lobes short, weak, but very expanded at base. Penis broad, with sclerotized areas on sides at base. Tibiae of middle legs (Fig. 4,h) expanded, flattened on outside; 1st segment of tarsus very dilated, three times as long as greatest width. Tibiae of hindlegs (Fig. 4,i) greatly dilated and thickened in middle and apical parts; tarsal segments greatly dilated, flat, 1st segment broadly round on hindmargin, scarcely more than twice as long as its greatest breadth.

Shining. Head densely punctate, punctures almost contiguous, forming a reticular sculpture on face, or distance between them not exceeding 1/3-1 diameter. Puncturation of trunk finer, less distinct, somewhat sparser, interspaces between punctures often exceed their diameter, strongly shining. Puncturation of mesonotum and scutellum coarser, dense on periphery, much sparser in center, where some interspaces between punctures may reach several diameters. Puncturation of metanotum more uniform and less distinct. Central area

of intermediate segment densely and coarsely reticularly shagreened, mat, shining at margins, impuctate; adjacent parts shining, punctate, interspaces between punctures 1/2-1 diameter. Basal parts of tergites strongly shining, with rare, coarse, uneven puncturation, interspaces between rows of punctures more than several diameters. Apical parts very shining, indistinctly shagreened. Sternites shagreened, with rather dense puncturation at sides. Puncturation of legs rather dense, irregular.

Brownish black. Tips of mandibles reddish. Tyloids of antennae brown, tegulae, veins of smoky yellow wings yellowish brown; subcosta and media dark. Apical crossbands of tergites a bleached yellowish brown. Spur pale yellow.

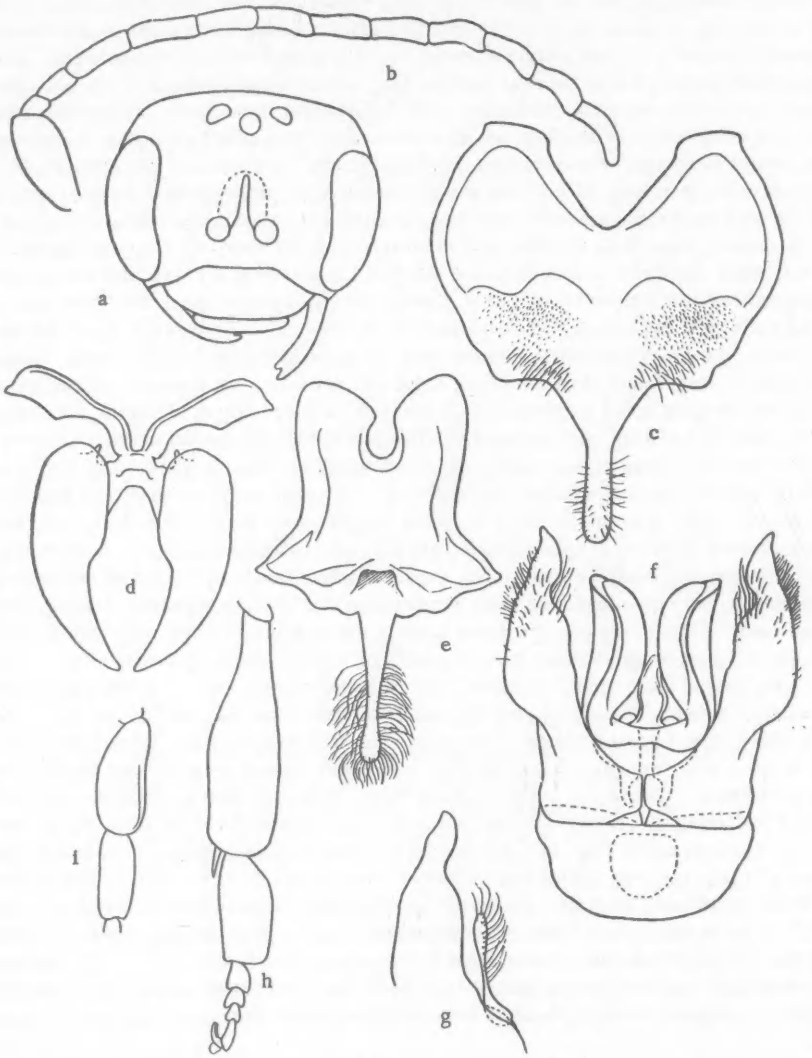

Fig. 4. Halictoides (Cephalictoides) spiniventris Popov, sp. n. a) Head from front; b antenna; c) 6th sternite; d) 7th sternite; e) 8th sternite; f) copulatory organ, dorsal view; g) volsella; h) tibia and 1st tarsal segment of middle legs; i) tibia and tarsal segments of hindlegs.

Body with dense long grey erect hairs, denser on face, clypeus, lower part of head, and denser and whiter on foremargin of hindtibiae. Hairs on sides of face and on temples black, just like the hairs on 5th-7th tergites. The pubescence of the tergites is shorter, sparser, semirecumbent, pale; the preapical rows of hairs are hard to distinguish. Sternites 2-4 with dense rows of white hairs on sides. Some hairs on fore-and middle legs golden.

♀ not known.

China, Ping-fang-chen, Nan-Shan, 6700 ft, July 20-21, 1908, 1 ♂ (P. Kozlov); Wangchiching, July 16, 1908, 1 ♂ (P. Kozlov).

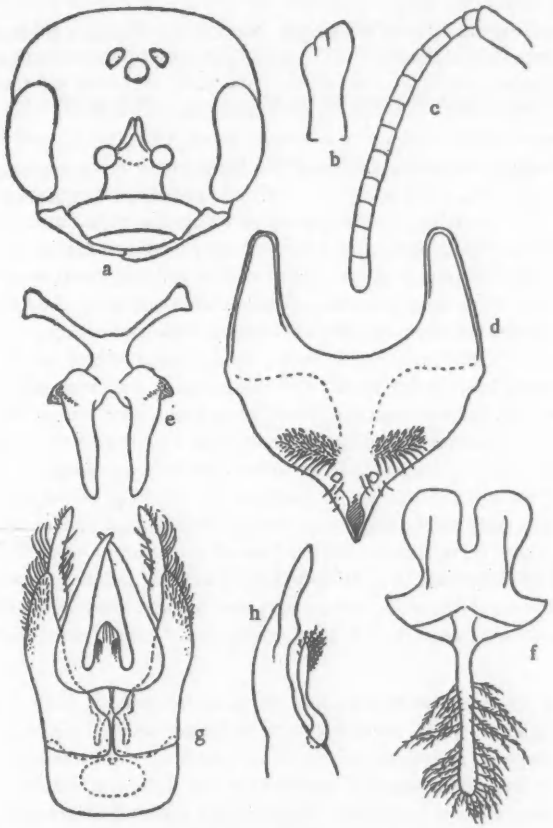

Fig. 5. Halictoides (Cephalictoides) mandibularis Popov, sp. n., ♂.
a) Head from front; b) mandible; c) antenna; d) 6th sternite; e) 7th sternite; f) 8th sternite; g) copulatory organ, dorsal view; h) volsella.

It differs markedly from all the palaearctic species of the genus by its large size, long antennae, structure of middle and hindlegs, and details of structure of abdominal segments.

HALICTOIDES (CEPHALICTOIDES) MANDIBULARIS POPOV, SP. N.

Rhophites atrocoeruleus F. Morawitz, Bull. Acad. Sci. St. Petersburg, , XXVI, 1880, 356, ♂; Melang. biolog. Bull. Acad. sc. St. Petersburg, X, 1880: 470, ♂ (nec. F. Morawitz, 1876).

♂. Length 9 mm. Head (Fig. 5,a) large, rather flat, of equal length and breadth, weakly rounded on vertex and slightly angulate at sides. Distance from apex of eyes to margin of vertex almost 1 1 1/2 times as long

as greatest width of eyes. Temples developed only at upper half of eyes, equal to their width. Eyes round on outer margin, noticeably converging on inner. Distance between lateral and median ocelli equal to half diameter of latter, distance between lateral ocelli and margin of vertex equal to four times their diameter. Labrum oval, rather convex, but flattened centrally, twice as broad as long, equal to half length of clypeus. Mandibles (Fig. 5,b) rather long, broad, weakly bent, with three teeth at apex. Maxillary palps 6-segmented, rather long, the two basal segments noticeably thickened, all of almost equal length. Labial palps 4-segmented, shorter, apical segments shorter than basal. Proboscis short, much shorter than praementum. Clypeus three times as broad as long, with almost straight foremargin. Distance from antennal pits to margin. Distance from antennal pits to margin of clypeus almost equal to twice their diameter. Scape of antenna (Fig. 5, c) thick, bent three times as long as its greatest width; 1st segment of flagellum equally broad and long, spherical; 2nd twice as long as broad; 3rd noticeably longer than 2nd; 4th and all subsequent barely shorter than 3rd, with large tyloids, gradually increasing in size and occupying, beginning with 6th segment, almost the whole length of the segment. Face from base to middle distinctly angularly impressed and bearing a strong, convex longitudinal keel, which becomes broader and higher toward the base of the antennae and then merges into the slightly raised base of the supraclypeal area. Horizontal part of intermediate segment long, but not longer than scutellum, angulate. Abdomen rather narrower, not strongly produced. Apical parts of tergites weakly impressed, equal to 2/3 length of tergite, narrower at sides, where basal part is more convex. Seventh tergite round at apex, without pygidium-like process. Fifth sternite broadly and roundly emarginate on apical margin, with an irregular transverse impression, separating the lower basal part from the higher apical part. Sixth sternite (Fig. 5,d) large, with large and narrow basal lobes, with a long, sharply produced apical margin, narrowly and heavily chitinized at apex. Seventh sternite (Fig. 5,e) with rather narrow and long basal lobes, with angulate expansions at free ends; apical lobes narrow and long, parallel, thickened dorsoventrally, only the connecting basal part between them flat; apical lobes ventrally angularly expanded at base and bearing a transverse band of short spines. Eighth sternite (Fig. 5,f) with characteristic stout, angulate basal lobes, divided by a narrow notch, three times longer than broad; lateral lobes rather broad, with sharp angles, not produced backwards; apical part narrow, longer than sternite, slightly bent ventrally, round at free end, with rather dense and long pulmose hairs over almost the whole extent. Gonobase of copulatory organ (Fig. 5,g) almost three times as broad as long dorsally. Gonocoxites more than twice as long as their greatest width at base, strongly converging toward apical part, round on outer margin, emarginate of inner. Gonostyles narrow, long, weakly bent, not separated from gonocoxites on the ventral side, with rather long hairs. Volsellae (Fig. 5,h) one-segmented, long, slender; base of volsellae expanded a little and lying almost freely in base of gonocoxite; the apex bears a series of plumose hairs. Sagittae noticeably bent dorsoventrally, strongly dilated at base, rather narrow laterally; apices of sagittae acute, rather long; basal lobes short, weak, but strongly expanded at base. Penis broad, with sclerotized areas on sides at base. Legs slender, shapely; tibiae of middle and hindlegs noticeably expanded, with ribbed hindmargin.

Shining. Head densely punctate, interspaces between punctures varying from 1/2 to 1 diameter, punctures grouped in denser patches in places; small areas devoid of punctures above the eyes, on the sides of the ocelli, and on the sides above the clypeus. Punctures on clypeus coarser than on remaining parts of face. Pronotum shagreened, indistinctly punctate. Puncturation of mesonotum and scutellum similar to puncturation of head, puncturation of shagreened sides of trunk indistinct. Intermediate segment shagreened, mat, puncturation of sides very delicate, dense; central area irregularly ribbed. Basal parts of abdominal tergites very delicately shagreened, with sparse and delicate punctures, the interspaces being equal to several diameters, but noticeably denser at very base of tergite. Sternites densely shagreened, with sparse punctures on sides; in center of apical margin of 4th sternite there is an area covered with coarse punctures bearing short, golden, recumbent, forward-projecting seta-like hairs.

Black. Face and vertex with blue metallic luster. Tips of mandibles, tegulae, veins of pale yellowish wings reddish or yellowish brown. Spurs pale yellowish. Body with sparse and rather short yellowish white hairs. Hairs of head, dorsum of trunk and abdomen black. Foremargin of clypeus with a dense fringe of rather long white hairs. Some hairs on legs golden.

♀ not known.

China, southern spurs of south Tatung Range, Kansu, first half of June, 1872, 1 ♂ (N. Przheval'skii and M. Pevtsov).

It differs distinctly from all the palaearctic species by the three-toothed mandibles, large head with high vertex, the stout, clearly delineated keel at base of antennae, the patch of seta-like hairs on the 4th sternite, the black hairs on the head, notum and tergites of the abdomen.

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NEW SPECIES OF MIDGES (DIPTERA, TENDIPEDIDAE) FROM LAKE BAIKAL

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GENUS SERGENTIA KIEFF.

Subgenus Baicalosergentia Linevich, subgen. nov.

Male; female. The antennae of the male consist of fourteen segments. The antennae of the female consist of seven segments. The pronotum is well developed in dorsal view, and constricted in the center. The first segment of the anterior tarsus is longer than the tibia. The scale of the anterior tibia is rounded. The middle and posterior tibiae are continuously pectinate and bear two clearly visible spurs. The pulvilli are large. The wing membrane is hairy; in the male the hairs are borne on the upper surface, and in the female either on both surfaces or only on the upper surface. The hypopygium of the male bears two pairs of appendages.

The type of the subgenus is Baicalosergentia aspidocephala Linevich, sp. n.

1. SERGENTIA (BAICALOSERGENTIA) ASPIDOCEPHALA LINEVICH, SP. N.

Male; female. The supralabral region of the head is unustually well developed. The supralabral sclerite takes the form of a ring, bearing a membranous plate; anteriorly it passes to the labrum, while posteriorly it is covered by the clypeus (Figs. 1, 2, 3). The antennae of the male consist of fourteen segments. The terminal antennal segment is longer than the 13th segment in the ratio 2.5 : 2. The antennae of the female consist of seven segments. The 4th, 5th and 6th antennal segments of the female have long constrictions. The terminal antennal segment in the female is 3 times longer than the penultimate one. The maxillary palpi consist of four segments. The pronotum is narrow in dorsal view, and constricted in the center. The first segment of the anterior tarsus is 1.2 times longer than the tibia. The anterior tibia has an oval scale. The anterior tarsus of the male bears long hairs (hirsute). The middle and posterior tibiae are continuously pectinate and bear two clearly visible spurs. The first antennal segments and the head are brownish black. The antennal flagella, maxillary palpi and supralabral plate are brown. The thorax is brownish black, covered with gray scales. The anterior legs are dark brown, as are the tarsi, distal halves of the tibiae and distal ends of the femora of the middle and posterior legs. The femora, except for the distal ends, together with the upper halves of the tibiae of the middle and posterior legs, are light brown. The pulvilli are large and broad. The wing (Fig. 4) has a well-developed membrane. The inner angle of the wing is straight. The wing membrane is covered with hairs; in the male these are borne on the upper surface, while in the female they are either borne on the upper surface or are sparsely distributed on both surfaces of the wing.* The wing veins C, R_1, R_{4+5}, rm and the base of M are brown. The wing-scale is hairy. The abdomen is brownish black in the male; in the female it is brownish black with fine, light gray hairs on the distal border. The abdominal tergites are covered with long, grayish hairs. The hypopygium (Fig. 5) is dark brown. The terminal segment of the hypopygium bears short, straight hairs on its inner surface. The first hypopygial appendages are narrow, smooth and curved inward. At the base,

*The degree of wing hairiness varies widely in different individuals.

they bear long hairs. The second hypopygial appendages are flattened dorsoventrally in the proximal half and laterally in the distal half, so that, depending on the position of the hypopygium, they may appear clavate or almost rod-shaped; they are long and extend to the end of the upper third of the terminal hypopygial segments. The distal parts of the second appendages are covered with strong, fine, almost-straight setae. The dorsal lamina is wide and large. Its edge bears long, fine setae and short hairs. The apex of the dorsal lamina is thin, flat, and rounded at the top; it extends to the end of the basal hypopygial segments. Male 8 mm; female 6 mm.

The midges were collected on the southwest shore of Lake Baikal, near the settlement of Bol'shaya Kota, on 7th and 8th July, 1947(11 specimens), 13th June, 1954 (10 specimens) and 16th July, 1955 (4 specimens). Part of the material is preserved dry, and part preserved in 70% alcohol.

2. SERGENTIA (BAICALOSERGENTIA) GOMPHOCEPHALA LINEVICH, SP. N.

Male; female. The supralabral and clypeal regions of the head are swollen and rounded. The clypeus is smooth and without setae (Fig. 6). The antennae of the male consist of fourteen segments. The terminal antennal segment exceeds the length of the 13th segment in the ratio 2.3: 2. The antennae of the female consist of seven segments; the 4th, 5th and 6th antennal segments have elongate constrictions. The terminal antennal segment in the female is almost twice as long as the preceding one. The maxillary palpi are made up of four segments. The pronotum is narrow in dorsal view. The first segment of the anterior tarsus is 1.2 times as long as the tibia. The anterior tibia has an oval scale. The anterior tarsus of the male bears short hairs. The middle and posterior tibiae are continuously pectinate and bear two clearly visible spurs. The head and first antennal segments are brownish black. The thorax of the male is brownish black with grayish scales. In the female, the thorax is brownish black with grayish scales and the scutum dark gray. The abdomen is brownish black, with long, gray hairs. The antennal flagella, the maxillary palpi and the legs are light brown, while the femora of the anterior legs and the tarsi are darker. The wing resembles that of S. aspidocephala (Fig. 7). The hypopygium resembles that of S. aspidocephala (Fig. 8). Male 6.5 mm; female 5.5 mm.

The midges were collected on the southwest shore of Lake Baikal, near the settlement of Bol'shaya Kota, on 9th August, 1949 (1 specimen), 16th July, 1955 (9 specimens) and 8th August, 1955 (8 specimens).

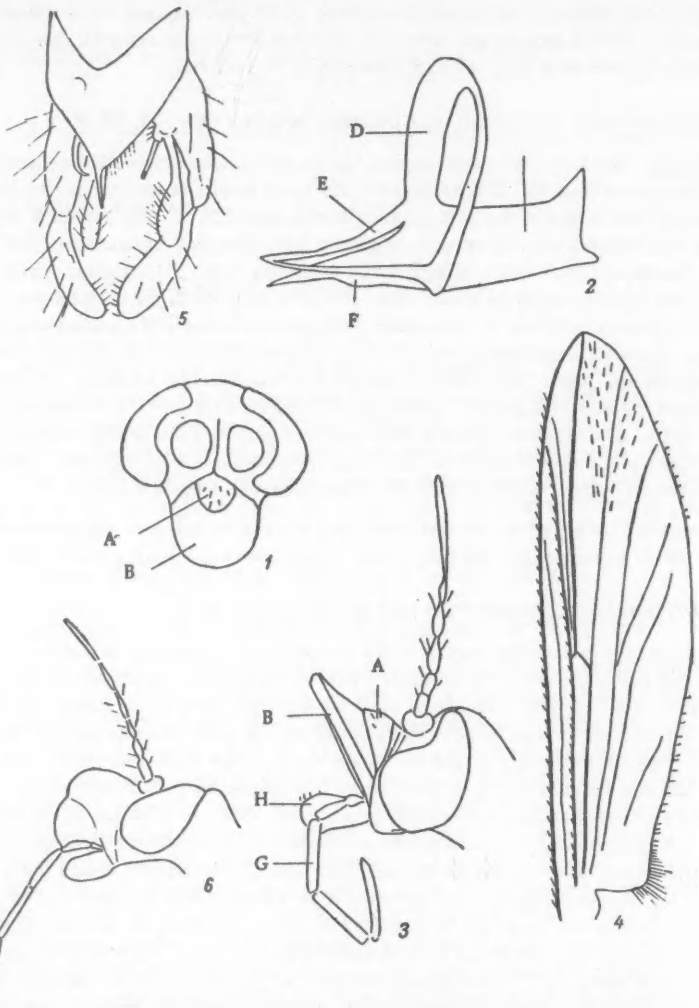
3. SERGENTIA (BAICALOSERGENTIA) MAGNA LINEVICH, SP. N.

Male; female. The supralabral region of the head and the clypeus are as before. The antennae of the male consist of fourteen segments. The terminal antennal segment is longer than the 13th segement in the ratio of approximately 3 : 2. The antennae of the female consist of seven segments. The terminal antennal segment of the female is two times longer than the penultimate one. The 4th, 5th and 6th antennal segment in the female have elongate constriction. The maxillary palpi consist of four segments. The pronotum is narrow in dorsal view. The first segment of the anterior tarsus is only slightly (1.1 times) longer than the tibia. The anterior tibia bears an oval scale. The anterior tarsus in the male has long hairs (hirsute). The middle and posterior tibiae are continuously pectinate and bear two spurs. The basal antennal segments, the head and the thorax are brownish black, with densely distributed, gray scales. The scutum is dark gray. The maxillary palpi, the antennae and legs are dark brown. The abdomen is dark brown, with gray hairs. The pulvilli are large and broad. The wing membrane is covered with hairs; in the male these are borne on the upper surface and on the veins, while in the female they are borne on both surfaces of the wing. The hairs are more densely distributed on the upper surface of the wing. The wing membrane is not well developed. The inner angle of the wing is straight, as in S. aspidocephala and S. gomphocephala. The wing veins C, R_1, $R_4 + s$, rm and the base of M are dark brown. The hypopygium is illustrated in Fig. 9. The terminal hypopygial segment bears straight, densely distributed hairs on the inner surface. The first appendages are short, curved inward, and attain less than one third of the length of the basal segments. The first appendages bear short, fine hairs at the base. The second appendages are long, almost equal in width to the upper part of the terminal segment of the valve, and with small pits on the inner surface. The apices of the second pair of appendages are almost triangular, with long, slightly bent setae. The dorsal lamina is wide, with long setae on the margin. The apex of the dorsal lamina is rounded and relatively short. Male 10 mm; female 9 mm.

The midges were collected on the southwest shore of Lake Baikal, near Listvennichnyi headland, on 4th June, 1943 (4 specimens), and near Bol'shaya Kota on 4th August, 1955 (3 specimens). The specimens collected in 1943 were preserved in 70% alcohol.

4. SERGENTIA (BAICALOSERGENTIA) FUSCIPENNIS LINEVICH, SP. N.

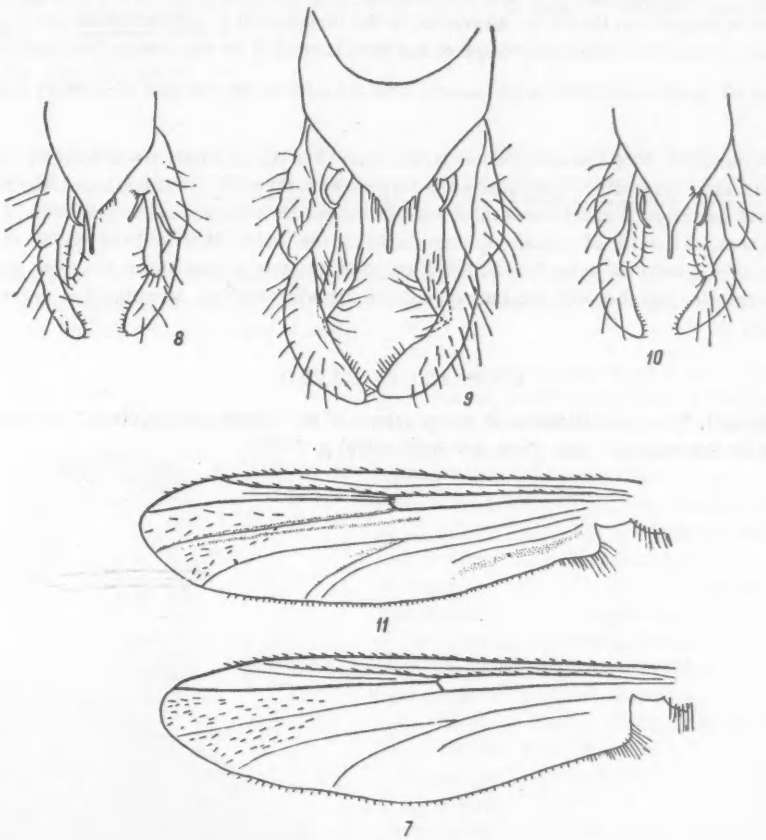
Male; female. The supralabral region of the head and the clypeus are as before. The antennae of the male consist of fourteen segments. The terminal antennal segment is longer than the 13th segment in the ratio 3.5 : 2. The antennae of the female consist of seven segments. The terminal antennal segment is twice as



Figs. 1-5. Sergentia (Baicalosergentia) aspidocephala, sp. n.: 1) head (dorsal view); 2) chitinous skeleton of supralabral plate; 3) head (lateral view); A – clypeus; B – supralabral plate; C – fulcrum; D – chitinous skeleton of supralabral plate; E – chitinous skeleton of upper lip; F – hypopharynx; G – maxillary palp; H – lower lip; 4) wing; 5) hypopygium. Fig. 6. Sergentia (Baicalosergentia) gomphocephala, sp. n.: head (lateral view).

long as the penultimate one. The maxillary palpi consist of four segments. The pronotum is narrow in dorsal view. The first segment of the anterior tarsus is 1.2 times as long as the tibia. The anterior tibia has an oval scale. The middle and posterior tibiae are continuously pectinate and bear two long spurs. The anterior tarsi of the male have long hairs (hirsute). The pulvilli are very well developed. The antennae and head are

brownish black. The thorax, mesonotum and metanotum are brownish black, with gray scales; the scutum is dark gray. The femora and tibiae are light brown, with dark spots at the distal ends. The first tarsal segments and the upper halves of the second tarsal segments are light brown. The lower halves of the second tarsal segments, together with the third, fourth and fifth tarsal segments, are dark brown. The abdomen is dark gray with light gray rings on the distal borders of the tergites. The hairs on the abdominal tergites are long and grayish. The wing membrane is supplied with hairs; in the male these are borne on the upper surface, while in the female they appear on both surfaces. The wing membrane is well developed. The inner angle of the wing is



Figs. 7-8. Sergentia (Baicalosergentia) gomphocephala, sp. n. : 7) wing; 8) hypopygium. Fig. 9. Sergentia (Baicalosergentia) magna, sp. n. : hypopygium. Fig. 10-11. Sergentia (Baicalosergentia) fuscipennis, sp. n. : 10) hypopygium; 11) wing.

acute. The wings are narrow and slightly darkened. There are dark bands along M, Cu, f-Cu and An; rm is darkened (Fig. 11). The wing-scale carries hairs. The hypopygium (Fig. 10) is dark brown. The terminal segment of the valve is relatively broad, with straight, strong hairs on the inner surface. The first appendages are narrow, long, half the length of the second appendages, and bent inward at the apex. At the base of the first appendages there are rather long hairs. The second appendages of the hypopygium are long, straight, but slightly bent on the outer surface. The apices of the second appendages are straight, with two stiff, bent setae. Similar bent setae occur on the whole distal surface of the second appendages. The dorsal lamina is large, oval and with long setae on the margin. The apex of the dorsal lamina is long, thin, rounded on the top, and reaches three quarters of the way along the second pair of hypopygial appendages. Male 7 mm.

The midges were collected on the southwest shore of Lake Baikal, near Kadil'nyi headland, on 7th August, 1955 (25 specimens). Part of the material was preserved in 70% alcohol.

We recognize this group of Sergentia species as the separate subgenus Baicalosergentia on the following grounds:

In the earlier-established species of the genus Sergentia the antennae of the female consist of six segments. The length of the first tarsal segment equals that of the tibia. In the species Sergentia aspidocephala, S. gomphocephala, S. fuscipennis and S. magna the antennae of the female consist of seven segments, and the first tarsal segment is longer than the tibia. Moreover, in the imagines of S. aspidocephala and S. gomphocephala the structure of the clypeus and supralabral region of the head is unusual for the family Tendipedidae.

The types of all species described in the present work are kept in the Institute of Zoology AN SSSR in Leningrad.

Larvae. Chernovskii (1949) has described as larvae from Lake Baikal three new species of Sergentia: Sergentia? flavodentata, Sergentia? baicalensis and Sergentia? bathyphila. The relationship between the midges that we have described as species and those established earlier as larvae is not yet clear. Although it is highly probable that, as a result of studies on metamorphosis, the names that we have given to certain species will prove to be synonyms, nevertheless, the distinctive structure of two of the described species of the subgenus Baicalosergentia, together with the lack of work on the winged phase, stimulated us to the publication of the present study.

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IN MEMORY OF IGOR' VASIL'EVICH KOZHANCHIKOV (1904-1958)

A. A. Shtakel'berg

On May 9, 1958 Igor' Vasil'evich Kozhanchikov, Doctor of Biological Sciences, one of the most outstanding workers in the field of entomology in the USSR, Head of the Insect Ecology Division of the Zoological Institute, Head of the Department of General Entomology of the Institute of Applied Zoology and Phytopathology, died suddenly from an acute myocardial infarction.

I. V. Kozhanchikov was born in Petersburg on February 28, 1904 into the family of Vasilii Dmitrievich Kozhanchikov, a great nature lover, an energetic insect collector and entomologist, a distinguished researcher in systematics, and a musician and composer as well.

I. V. received his secondary education in Minusinsk, Krasnoyarsk Territory, where he also began his working life as a trainee in the local N. M. Mart'yanov Museum. In 1924, I. V. was sent to Leningrad for the advanced course in applied zoology and phytopathology; at the same time I. V. entered Leningrad State University of an external student (vol'noslushatel'). On the completion of his higher education (prescribed courses and university) in 1930 I. V. was appointed as lecturer, and later as docent in the Department of General Entomology of Leningrad Agricultural Institute, where he worked until 1935. In Minusinsk I. V. had aready begun his scientific work on the biology and ecology of vertebrates – mammals and birds; his first scientific work had already been published in 1923. Later, I. V. went on to the study of insects, on which he had started scientific work while still a student in 1924 in the Zoological Museum (now Institute) AN SSSR. During the summers of 1926-1928 he carried out research on phylloxera and its control in Transcaucasia and Central Asia. I. V. took up his investigatory work on entomology in the All-Union Institute of Plant Protection in 1932, and later, in 1934, in the Zoological Institute AN SSSR, but he did not give up his teaching activities. In 1942, I. V. was elected Head of the Department of General Entomology in the Institute of Applied Zoology and Phytophathology where he worked until the last days of his life. I. V. spent the whole period of the blockade in Leningrad, carrying on with his work in the Zoological Institute AN SSSR and at the same time continuing his work in the colleges; during the Great Patriotic War, I. V. was entrusted with the direction of the Zoology Department in the Herzen Pedagogical Institute in Leningrad; during the same period I. V. took an active part in the work of the Medical Administration of Lenfront in an advisory capacity and in the compilation of instructions and manuals.

I. V. was awarded the orders of the "Labor Red Banner" and "Badge of Honor" and the medals "For the Defense of Leningrad" and "For Valiant Service in the Great Patriotic War".

The scientific interests of L. V. were very broad. Along with his systematic work he devoted a great deal of energy and attention to studies of the biology, ecology, physiology and pathology and animals, mainly insects, and what was particularly valuable, these apparently independent branches of biology were to I. V. interwoven elements of a single whole – the biological phenomenon known as life.

I. V. made an immense and very valuable contribution to the study of the systematics of Lepidoptera. During the past 20 years L. V. has published three large volumes in the series "Fauna of the USSR", these being devoted to the Agrotinae (1937), Orgyidae (1950) and the Psychidae (1956); these volumes, in addition to the basic systematic treatment, give a full and thorough characterization of the groups examined – their morphology, biology ecology, distribution, evolution–and the importance of their members for man; in each of these sections L. V. always introduced a great deal of new and interesting material. For instance besides the study of the systematics of the Orgyidae he carried out extensive investigations of their ecology, particularly the effect of environmental conditions (food plants, temperature of surroundings, and so on); the systematic observations of L. V. in the field were supplemented withand interpreted through painstaking experiments in the laboratory, which frequently extended over several years and were conducted with exceptional persistence and tirelessness. In the sections dealing with the geographical distribution of the investigated groups, I. V. gave a broad outline of their ranges, linking together the information of the historical geography, evolution and contemporary ecology of the group with the systematics of its world representatives.

In his last years of life L. V. was working on a large monograph of the Cossidae of the USSR, which, unfortunately, was left unfinished; it had the same format as the other works of L.V., published in the series "Fauna of the USSR".

Besides his large compilatory works on the systematics of Lepidoptera, L. V. made a long series of revisions of individual genera and descriptions of individual species, mainly Lepidoptera, but also including Neuroptera.

L. V.'s works on zoogeography dealt with various problems and questions; in his systematic monographs L. V. gave stimulating accounts of the geographical distribution of the groups. Questions of zoogeography received special treatment in the works of I. V. on discontinuities in the distribution of certain noctuids (1935), on the ranges of injurious species of soil-dwelling noctuids (1935), on the types of ranges of insect pests (1941) and certain others. Of great interest are the works of I. V. on the ecological premises for a zoogeographical division of Eurasia (1946), on the Angara genesis of the holarctic fauna (1948), etc. In recent years L. V. has devoted a great deal of attention to a study of the Lepidoptera of the Karelian Isthmus; crammed with notes on the ecology of individual species and on the group as a whole, this work was published after I. V.'s death (1958).

As regards ecology in the wide sense I. V. also made a very large contribution. Particularly successful were his studies on the importance of environmental factors in the distribution of insects, on the ecological optimum, on diapause and overwintering, and lastly, on the variation in individual structure in relation to environmental conditions; the works in this last cycle impinge upon his researches on systematics, since they deal in fact with the problem of species formation. I. V.'s works on ecology are not described in more detail here, since the nest issue of "Entomological Review" will contain I. V.'s own outline of the works on ecology carried out in the USSR during the last decade, and which gives a full and clear picture, particularly of I. V.'s studies in this field.

Many of I. V.'s ecological works were concerned with pests; these apparently purely academic works of I. V. were of great practical importance.

Some of I. V.'s works dealt specially with the biology of pests; such, in particular, were his studies on vineyard pests (1930, 1931).

Besides special works on the ecology of individual species or on the role of different factors in the life of insects, L. V. contributed a very valuable manual on experimental methods in entomology (1937) which still retains its value up to this time, despite the considerable progress in this field. At the present time the "Science" Press is printing a second, completely revised and enlarged edition of this book, which also contains besides the experimental methods, an account of methods of ecological investigation in the field; this book is scheduled for publication in 1959.

An outstanding personality and a born scientist, L. V. possessed one quality to a very high degree – an exceptional capacity for scientific thinking. A man of great and calm courage, I. V. never ceased his scientific work, no matter how hard the conditions, even in the most severe periods of the Leningrad blockade. The legacy which L. V. has left in his works on entomology is a vast one.

The untimely death of Igor' Vasil'evich is a very heavy loss to Soviet entomology.

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* See English translation.

NEWS REPORTS

FOURTH INTERNATIONAL REGIONAL CONFERENCE OF ASIATIC COUNTRIES ON PARASITIC DISEASES OF ANIMALS

D. I. Blagoveshchenskii

The IV International Regional Conference of Asiatic Countries on Parasitic Diseases of Animals, which was organized jointly by the International Bureau of Epizootic Control and the Ministry of Agriculture for the USSR, was held at Alma-Atar in Kazakhstan from May 31 to June 7, 1958. Delegates from Japan, the Islamic Republic of Pakistan, the Korean People's Republic, the United Arabic Republic, the Republic of Indonesia, the Mongolian People's Republic, the Democratic Republic of Vietnam, Cambodia and the International Bureau of Epizootics took part in the proceedings.

The conference received the report of the Permanent Commission of the International Epizootics Bureau for Asiatic Countries and separate reports on protozoan diseases, helminthoses, and arachnoentomoses of animals. During the discussion following the report to the praesidium of the conference, permission was kindly granted to representatives of five Soviet scientific institutions, allowing them to come forward with their reports. In particular, the present author was able to speak on basic trends in parasitological research dealing with problems in arachnoentomology in the USSR, including the important studies of Academician E. N. Pavlovskii on natural foci of endemic diseases.

The conference put forward recommendations relating to protozoan diseases, helminthoses, and arachnoentomoses in animals. Among the recommendations, with respect to arachnoentomoses there was expressed a wish by the Asiatic countries that the following measures be accomplished: an intensification of research of ticks as vectors of disease; the utilization of effective measures to destroy ticks on animals and in natural biotopes; together with a study of the role played by bloodsucking insects as possible vectors of pathogens among animals; the improvement of insecticides and repellents; the organization of veterinary sanitary control at frontiers, and the treatment of all imported animals against parasites.

Those participating in the Conference had the opportunity of examining displays furnished by veterinary scientific institutions and seeing something of the work of scientific, pedagogical and practical institutions concerned with veterinary science. In addition, it was possible to visit various animal welfare stations belonging to the State and collective farm network, and under the control of the Parasitological Base of the Academy of Sciences, Kazakhstan SSR. These were situated in and around the town of Alma-Ata.

ENTOMOLOGICAL RESEARCH REPRESENTED AT THE FIFTEENTH INTERNATIONAL CONGRESS OF ZOOLOGY IN LONDON

D. M. Shteinberg

The XV International Zoological Congress in London attracted the attention of zoologists from all parts of the world. The date was an important one – the centenary year of the publication by Darwin and Wallace of their ideas on evolution – and hence the congress was given over to a summary of the contemporary state of Darwinism in the various fields of present-day zoology. Papers dealing with topics relating only slightly – or not at all – to evolution, did however predominate. On the whole the papers were short, but there was a large number of them (over 400) and they were divided into 12 sections. There were few papers dealing with broad generalizations; nor were there any in which outstanding new ideas were set forth regarding the future development of evolutionary theory.

No special section in the Congress was devoted to entomology. The sessions of the various sections were arranged according to particular general topics dealt with in the papers read at that session. Hence, papers dealing with entomological research were read at a variety of different times depending on their relationship to the general topic being dealt with at at that time in a given section. Only a fragmentary idea of the entomological research being carried out in the different countries could be obtained from the conference as a result of this method of treatment. Twelve per cent of the papers read at the Congress dealt mainly with experiments and observations on insects.

Insect morphology was poorly represented among the papers. A solitary paper dealing with comparative anatomy was given by S. M. Manton (London) and in the main was based on work on the Myriapoda; the primitive insect orders constituted only a part of this paper. An attempt was made to analyze the historical development of Arthropod groups in the light of the peculiarities of functional morphology displayed in their structure. In a paper by A. G. Sharov (Moscow), morphological changes taking place during ontogeny in different orders of insects was used to illustrate the possible phylogenetic beginnings of new insect groups. A paper by Weiss-Fogh (Cambridge) was mainly devoted to an account of the biomechanical properties of insect tissues at the time of flight. He established the occurrence of a high degree of elasticity in the cuticle of the thorax and wings and in the wing musculature, and expressed an opinion as to the probable aerodynamical properties associated with it.

Problems of ontogeny were dealt with in several papers. D. F. Poulson and D. F. Waterhouse (New Haven, USA) studied the behavior of the polar cells in the embryological development of certain Diptera and they found only a part of them gave rise to the primary gametocytes, whereas the rest contributed to the midgut. The development of the gonads in Anacridium aegyptium L. was the substance of the paper by G. Colombo (Padua), M. Vuillomme (Rennes) dealt with the ontogeny of hive-bee larva, in natural and artificial cells.

Cytological problems were discussed in a series of papers. G. Montalent and L. Frantini (Naples) have studied spermatogenesis in male stick insects Bacillus rossius Rossi. J. Bergerard (Paris) found that in parthogenesis of another species of stick insect Clitumnus extradentatus, and also in the parthogenesis which occurs occasionally in Locusta migratoria, doubling of the chromosomal complement takes place during embryological development and does not take place simultaneously in the various cells and tissues of the embryo. The restoration of the diploid condition was found to depend on temperature conditions during the development and this may reveal the way by which geographical, parthenogenetic races come into being. B. A. Astaurov (Moscow)

dealt with the origin of triphoid parthenogenesis in Bombyx mori L. The karyotype of a Brazilian species of Anopheles was the subject of a paper by G. Schreiber and A. S. Guedes (Brazil).

G. Cousin (Paris) reported on his new researches into species formation among crickets. His report dealt with a morphological and genetical analysis of individuals, obtained as a result of crossing European and American species.

A paper by Bei-Bienko (Leningrad) was devoted to the general topic of ecological adaptation. He discussed new examples selected from different orders of insects, illustrating the principles which he had established at an earlier date with respect to locusts. These principles relate to habit change from one climatic zone to another, and in his paper, Bei-Bienko showed that such a change could be an initial step in the divergence of species. M. S. Gilyarov (Moscow), in a session especially devoted to soil fauna, put forward an elaboration of his earlier ideas on the evolution among insects of specific adaptations to living in the soil.

The dynamics of insect populations were dealt with in two papers. M. Lloyd (Chicago) determined the increase and decrease in numbers of the beetle Tribolium castaneum Herbst in the laboratory, using strains of different genetical constitutions reared under identical conditions. H. Klomp (Wageningen, Holland) analyzed the population dynamics of the bordered white moth (Bupalus piniarius L.) in relation to the multiplication of its tachinid parasite Carcelia obesa Zett; this analysis was based on the author's studies of six years duration, in one of the Dutch forests.

Y. Gosswald (Wurtzburg) summarized his researches on the ecology of the wood ant (Formica rufa L.). H. Sander (Warsaw) dealt with certain ecological peculiarities of two pests of stored products – Calandra granaria L. and Calandra oryzae L. G. Richard (Rennes) provided information on the ecological characteristics of certain aquatic Hemiptera. L. P. Brower (Oxford) examined the ecology of reproduction and mating in Papilio glaucus group. The behavior of different species of Drosophila was the topic of a paper by M. Bastock (Oxford). M. le Faucheux (Rennes) dealt with parasitic Hymenoptera, A. Bombosch (Gottingen) – the Syrphidae, F. A. Urquhart (Toronto, Canada) – migratory Lepidoptera. The topic of food storage among African ants of the two genera Monomorium and Pheidole was the subject of a paper by J. H. Sudd (Nigeria).

A series of papers were read which threw light on the problem of locust behavior. R. C. Rainey (London) described new methods for the detection of swarming, which should permit a better assessment to be made of the direction of migration (see the article by G. Ya. Bei-Bienko in the present issue of the Entomological Review). G. Richard (Rennes) studied the flight of Locusta migratoria L. and Schistocerca gregaria Forsk. with special reference to the effect of light intensity on the onset of sexual maturity. P. E. Ellis (London) showed that the migratory instinct of the locust nymph only manifests itself when sufficient numbers of its fellows are present, as can be observed in laboratory experiments. By contrast, the migratory instinct is never found among grasshopper nymphs.

Biochemical change was the subject of several papers. M. Rockstein (New York) studied the biochemical changes taking place in insects during imaginal life. He showed, for example, that in hive bees, house flies and other Diptera there is an increase in acetylcholinesterase activity in the imaginal phase of the existence, which is in accord with the increase of neuromotor functions in relation to the insects' assumption of the power of flight. He attached a somewhat exaggerated importance to the so-called biochemical imaginal maturation of metahemogenesis.

H. W. Ludwig (Heidelberg) investigated the fatty acid consumption of dipterous insects during flight in relation to their body weight. In Drosophila melanogaster Lw., D. funebris F., Musca domestica L., Phormia regina Mg. and Calliphora erythrocephala Mg. the consumption of fatty acids during flight (as also during rest) increased in proportion to their weight, at a constant mean rate of fourteen times the fatty acid consumption – 22 cm^3 per 1 g per hour, in a given species at rest.

In a paper by H. J. Vonk and J. W. Seele (Eindhoven, Holland) the fat metabolism of Calliphora was discussed; in a paper by J. E. Treherne (Cambridge) – consumption of sugar by locusts. The results of electrophysiological analysis of the optical centers in insects was described in a paper by H. Autrum (Munich).

In a special session devoted to the problems of neurosecretion and hormonal factors in Invertebrates, M. Gersh (Jena) dealt with the role of neurohormones in the development of pigmentation in a series of insect species. B. Possompes (Paris) studied the importance of endocrinal and neural factors in the regeneration of the extremity of the body of the stick insect, Sipyloidea sipylus W.

A different session was given over to the physiological mechanism involved in the development of resistance to insecticides. In this session were featured papers by A. W. A. Brown (Ontario), J. R. Busvine (London), H. Luers (Berlin), G. Davidson (London) and P. Winteringham (Slough). In all these papers, the development of resistance toward DDT was noted and the last of these authors also mentioned the tolerance of insects for other insecticides, in particular, aldrin and parathion.

Certain papers dealt with zoogeographical questions. J. L. Gressit (Honolulu) showed that analysis of the distribution of insects, notably Orthoptera, in the Malayan Archipelago, New Guinea and northern Australia suggests that the zoogeographical boundary between the Indo-Malayan and Australian regions – Wallace's Line, which has established in terms of mammalian and avian zoogeography – is not valid for insects.

D. Povolny (Brno) investigated the distribution of European geometrid moths of the genus Psolos; he found that those species of the genus which had a very limited range on distinct mountain tops or mountain ranges dated back to the Pliocene period, to the time when the Asiatic species of the genera Gnophopsodes and Gnophos split off from the main stock of more primitive members of the evolutionary group. Despite this long period of isolation, the presence of similar conditions in their environments has led, in certain cases, to convergent evolution between the distinct Asiatic and European species which has resulted in their sharing very close similarities of form and color.

A. Alberti (Berlin) demonstrated the way in which a natural system of classification based on the historical development of a given family may be constructed, using the Burnet moths, Zygaenidae, as his example. The evolution of the Tachinids in relation to their parasitism was described in a paper by F. J. Embden (London).

So many papers were submitted to the Congress, that of necessity, not all of them (including about twenty entomological) could be read before the various sessions; these latter papers appeared on the general program only as titles. However, they will be included in "The Transactions" of the Congress.

Many scientific films were shown at the Congress, and of them, seven dealt with insect biology. Of great interest was a marvelous color film dealing with tropical Africa – "The Life of Termites", directed by Dragescaux, with the scientific collaboration of Prof. Grasse, Paris. The rest of the films were as follows: "The Development of Spurge Hawk Moth, Deilephile euphorbiae L." (M. Gersch, Jena); "Darwin and Insect Adaptations in Brazil" (Kettlewell, Oxford); "Oviposition in the Tipulidae" (Hemmingsen, Denmark); "Blood sucking Flies" (Hoff, Canada); "Insects as Vectors of Disease because of Their Feeding on Blood" a popular science film by Gordon (Liverpool).

The Congress led to extensive contacts which forged friendly links between Soviet and foreign zoologists.

ANTILOCUST RESEARCH CENTER IN LONDON

G. Ya. Bei-Bienko

In July 1958, the author, as a participant at the 15th International Congress of Zoology in London, had an opportunity of visiting the Antilocust Research Center, at 1, Princes Gate, London, S. W. 7, and of acquainting himself with the work of this scientific organization. The period of sojourn in London was very short, 14-27 July, while the duties and interests were considerable; it was also necessary to find time to study some collections, (type specimens, etc.), in the division of Entomology of the British Museum of Natural History. Consequently, the survey of the Antilocust Center turned out to be necessarily brief and not as thorough as we desired; in spite of this, the author nevertheless considered it possible and worthwhile to present this brief information about the Antilocust Center, an interesting and instructive scientific establishment which is engaged in the solution of the most important modern entomological problem – the theory and practice of combating the locusts.

In its present shape the Antilocust Research Center was formed in 1946, but its history may be traced to 1929, when the Locust subcommittee was formed in London, and was soon reorganized into the Committee on Locust Control, affiliated to the Economic Scientific Council. The task of this Committee, which included a number of eminent scientific experts of England and some officials, was to examine and to present reports and lectures on the methods of warfare against the desert locust (Schistocerca gregaria Forsk. – Fig. 1*), and other gregarious locusts of tropical Africa, and on establishing of causes for their mass reproduction with a view to combating them. The basic organization work on the collection of the necessary information and on the formulation of research programs, and also the compilation of annual reviews and reports, was undertaken from 1929 by the small Locust Section at the Royal (currently British Commonwealth) Institute of Entomology in London, consisting of a member of the above-named committee, B. P. Uvarov and a technical assistant.

The Committee on Locust Control from the beginning has been very active and had published a number of reports, (Committee on Locust Control Reports, I and II, 1929; III, 1930; IV, 1932; V, 1933; VI, 1934), with short reviews and research programs, as well as 7 reviews on the multiplication of locusts in Africa and western Asia for the period from 1925 to 1937, inclusive, (B. P. Uvarov, The Locust Outbreak in Africa and western Asia in 1925-31, London, 1933; same, for 1932, London, 1933, etc.).

The activity of the Locust Control Committee soon produced results: the Locust Section at the Institute of Entomology had extended its research activities, became enlarged and emerged as the most important organizational and research center for locust control problems. In 1931, this section became known as the Antilocust Research Center, commonly called international, although this referred to the range of its work and not to its legal status.

In 1946 the Center assumed its present structure, left the Institute of Entomology and became an independent, (although temporarily so), scientific establishment with its present name.

The head of the Antilocust Research Center is Dr. B. P. Uvarov, F.R.S.; the deputy director is Dr. T. H. C. Taylor, and the secretary is Mr. A. T. Thompson.

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*The photographs from the British Information Bureau, published here, were obtained through the kind cooperation of the administration of the Antilocust Center.

The Center occupies an entire floor of a large building and consists of the following divisions: the Locust Laboratory, Geographical Section, Statistical Section, Section of Toxicology, (which is located outside London), library and office; the taxonomic research is conducted in the Department of Entomology of the British Museum of Natural History.

The entire staff consists of about 25 persons, including up to 10 research scientists. In fact, however, the number of scientists investigating various acridological problems exceeds this figure by far. This is achieved in two ways. First there are a number of temporary workers at the Center, mainly from abroad, who study their own material, prepare papers for publication or work on their doctoral theses. Secondly, the Center annually provides 5-10 stipends for work on special problems outside the Center; otherwise it would have been necessary to equip special laboratories at the Center and to increase the number it its scientific staff. The stipends are awarded to relevant organizations or to persons, and this, fundamental extramural research is being done in morphology, physiology, biochemistry, toxicology, physical properties of insecticides, etc. It follows, therefore, that the Center does not consider it practical to establish its own special laboratories for certain newly directed research projects, but stimulates their being undertaken by other organizations or persons most competent in any given field. This system allows for a quick solution of necessary problems, retains a constant staff at the Center itself, and does not require the staff to be changed or cut after a certain project has been completed.

On the whole, there is a wide range of research and a large scientific productivity, which can give priority to any scientific or practical problem. Without doubt, such a system or organization of scientific research is the most rational, economical and effective; it can be applied in various branches of scientific research and deserves to be widely copied.

It is to be pointed out that every research worker is obliged to do field work from time to time.

The work of the Antilocust Research Center is directed by the Scientific Council for Antilocust Research, consisting of 16 members and headed by Sir J. Evans. Among the members of the Learned Council are such eminent English scientists and experts as Prof. V. B. Wigglesworth of the University of Cambridge, Prof. J. Varley, (Univ. of Oxford), Prof. O. Richards, (Royal College of Science and Technology), the director of the Institute of Entomology, (formerly Dr. W. Hall), and others, representing physiology, ecology, applied entomology, tropical agriculture, meteorology, aerodynamics, and other sciences. Only 3 persons including the director and deputy director, from the Antilocust Center, may be included in the Scientific Council. Thus, the Scientific Council is a scientific body, independent from the Center, and is thus able to consider plans and the annual budget of the Center most competently and objectively, and to propose new research projects.

The annual budget of the Center is 70 thousand pounds sterling, which includes staff salaries and stipends for extramural research.

During the Zoological Congress there was an exhibition at the Antilocust Center, which showed its scientific achievements and methods. The cordial manner with which the administration and the staff welcomed all the visitors to the exhibition, created the most favorable conditions for aquainting one's self with the activities of the Center, and the author recalls this fact with much pleasure and gratitude.

The Locust Laboratory, under the direction of P. Hunter-Jones, is the most important part of the Center and has two main problems; breeding of various locusts for supplying different laboratories and investigators, and experimentation on living subjects in connection with problems which arise during field work. A large number of standard locust cages are located in two rooms with constant, automatically regulated temperature. The cages are well designed and very hand, (Fig. 2); they have a double bottom, the upper one made of galvanized iron with small holes, (up to 2 mm in diameter), through which excrements can pass with ease, but the smallest larvae cannot; the top can be removed, but it also has a door in it, which is convenient for cleaning the cages and for daily feeding; temperature regulation in the cages is achieved by means of three electric bulbs, - two below (between the two bottoms)-and one, mat, under the ceiling.

The locusts are fed with green grass with the addition of dry wheat bran; the bran reduced the requirement for green feed, which is especially important in the winter, but its total exclusion and substitution by an artificial diet is being studied. The cages always contain several dry twigs, placed vertically; this improves the living conditions for the locusts, facilitates molting and reduces mortality.

When they reach sexual maturity, the locusts are transferred to oviposition cages; these are the same standard cages, but with a number of round holes in the upper bottom, in which are placed, level with the floor, metal "soil" containers with packed moist sand, into which the egg clutches are deposited. The containers with the eggs are removed and replaced by new ones every 1-3 days. The containers are incubated at 28-30° C, and the sand is moistened from time to time.

The cages are cleaned and disinfected every 4-6 weeks by means of hot water and 0.5% solution of chlorocresol, the twigs are replaced, and the sand is sterilized by dry heat at 110°C for one hour before it is used again.

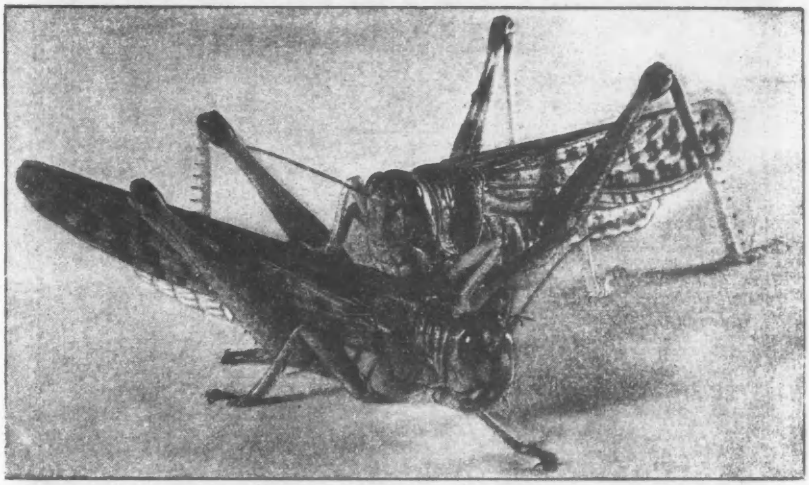

Fig. 1. Desert locust (Schistocerca gregaria Forsk.).

The following species are bred throughout the year in the laboratory: African migratory locust (Locusta migratoria migratorioides R. et F.), desert locust, (Schistocerca gregaria Forsk.), red locust, (Nomadacris septemfasciata Serv.), a number of leafhoppers, e.g., Egyptian leaf hopper, (Anacridium aegyptium L.), and representatives of the genera Euprepocnemis, Sphodromerus, Pyrgomorpha, Gastrimargus, etc. The migratory locust produces up to 5 generations a year, the desert locust up to 4, and consequently every week 2000 larvae and 600 immature adults are produce, and supplied for research purposes, (Fig. 3) to about 30 laboratories in England and in other countries (France, Italy, Germany, Australia, Canada, South Africa, etc.).

The following research work is being done. Dr M. J. Richards, (formerly Norris), studies sexual maturation and oviposition in locusts, as conditioned by environmental conditions, in particular, the length of the photoperiod. P. Hunter-Jones together with others continues to investigate the phase variability in gregarious and nongregarious locusts under different environmental conditions, in particular, the density of individuals during their growth. Dr. P. T Haskell continues the study of sense organs of locusts; on one hand, electrophysiological investigations of the aerodynamic sensory hairs which stimulate flight, and the tympanal organs of hearing and on the other hand, the histological study of the sensory hairs. Lastly, G. G. Cavanagh studies body weight and fat and water content in locusts as related to flight and maturation.

An interesting apparatus for the laboratory study of the flight of locusts has been constructed and used. It consists of a flat and wide horizontal tunnel made of aluminum, inside of which a number of winged locusts are suspended from metal loops which are fixed in their thorax; a constant stream of air is maintained in the tunnel by means of an electric fan, and this forces the locusts to perform flying movements with their wings, i.e., to "fly" without moving The prototype of this apparatus is the "merry-go-round" method, (Fig. 4). The use of this apparatus permits varied and exact physiological and biochemical investigations to be made with the flying locusts; it is necessary, however, to admit that this induced "laboratory flight" is somewhat artificial and probably does not quite correspond to normal flight in natural conditions.

The Geographical Section under Z. Walloff is also an important part of the Antilocust Center; for the last 30 years the section has been receiving information on the dynamics of three most important species of locust the desert locust. African migratory locust and the red locust. This section acts as a link in the cooperation with organizations abroad in work connected with locust research and control, and arranges for cooperative broad field research. The work of Dr. R. C. Rainey. Z. Walloff and others is to be singled out, particularly in the field of study of the mechanism involved in the movements of locust swarms, and particularly of the behavior of individuals in flying swarms and the movements of swarms in connection with air currents. For this the

Fig. 2. Desert locusts in a standard cage.

measurements of the size, structure. direction and speed of swarms is made, together with observations on atmospheric conditions (barometric pressure, temperature, humidity, wind and turbulence), at different altitudes, from the surface of the earth to the greatest heights attained by the flying swarms. These investigations require a wide use of light aircraft, colored balloons which are released during movements of swarms to study air currents, and other relevant apparatus, some of which has been especially constructed. The movements of the balloons are observed with the aid of teodelites, and exact data on air movement is thus obtained. Details of flight of locusts are established by photographing flying swarms, using a very sensitive film and a special camera

which takes double exposure every 1/50 of a second; a series of such films with double exposures of flying locusts acts as a source of information for the establishment of data on the speed, direction and altitude of flight density of the swarm, orientation of different individuals, etc.

One of the research methods is a constant and exact recording of the appearance of the first locust swarms, and their numbers in different places, as related to meteorological data.

On the whole, the movement of swarms depends to a large extent on wind. The observations of Dr. Rainey and others have shown that the behavior of locusts in swarms is quite individual, and strictly speaking, the swarm as such does not have it own direction of flight but there is merely a common impulse of the individuals to remain close together in the air. Thus migrations of locust swarms over hundreds and thousands of kilometers represent a passive displacement of masses of individuals which are themselves in active motion, and linked to each other by herd behavior.

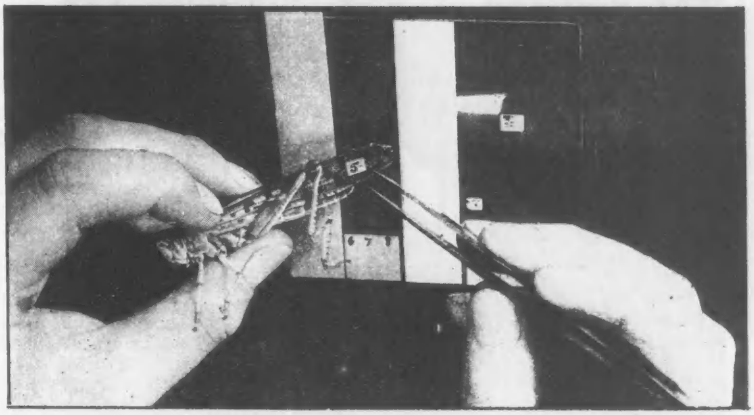

Fig. 3. Marking experimental locusts by means of sticking a colored square paper with a number.

The linking of the individuals of gregarious locusts between themselves in swarms is not destroyed even by the dispersing action of atmospheric turbulence, i.e., in whirlwind movements of different layers of air; the individuals maintain contact between themselves in the air, as do larvae in swarms, and this distinguishes the gregarious locusts from nongregarious ones The physiological basis of this contact and the part played for this purpose by the sense organs is being studied by Dr Haskell (see above).

Among other projects shown at the exhibition, the author's attention was also attracted by the investigations of J. T. Davey on seasonal migrations and population dynamics of the African migratory locust in West Africa. It became known that the locusts do not remain throughout the year in the same localities where massive invasions occur , but undertake seasonal migrations, occupying different territories, far removed from each other in different seasons of the year. During the period of summer rains the locusts migrate from the innundated plain of the middle Niger to drier, semidesert regions, which at that time of the year have a richer vegetation, but in the autumn, with the onset of the dry period and the drying-up of vegetation, they leave these areas and migrate toward the region which becomes innundated by the Niger. Thus, during the yearly cycle of the locusts there occurs a regular change of habitats, and this enables the locusts to multiply practically without interruption, which accounts for the fact that the production of 3, and perhaps 4 generations a year is normal. Preliminary data on these migrations of the African migratory locust and its population dynamics have been published by Davey in several short papers, (e.g., Davey, Bull, Soc. Entom. France, v. 61, No. 1-2, 1956), but soon the complete account will appear in "Locusta", published by the International Organization for the Control of the African Migratory Locust.

This seasonal change of territory by the African migratory locust is interesting from several points of view. First, it shows the complexity and the peculiarity of population dynamics of gregarious locusts; the

variation in their numbers, as opposed to other insects, is related to the displacement of swarms and the change in size of the populated territory, as well as to the qualitative change from the solitary stage to gregarious, and vice versa. Secondly, in its ecological essence, the seasonal change of territories is quite similar to the seasonal change of stations noted by the author, (Bei-Bienko, 1928), and by other workers in solitary locusts, and also found, as shown by L. Z Zakharov, (1946), in our Asiatic locust, (Locusta migratoria migratoria L.); in all cases this change is related to the change of humidity and temperature during the period of habitation of the locusts in certain localities. Thirdly, this seasonal change of stations represents, as recently well shown by L. V. Stebaev (1957), merely an isolated manifestation of the principle of the change of stations, proposed by the

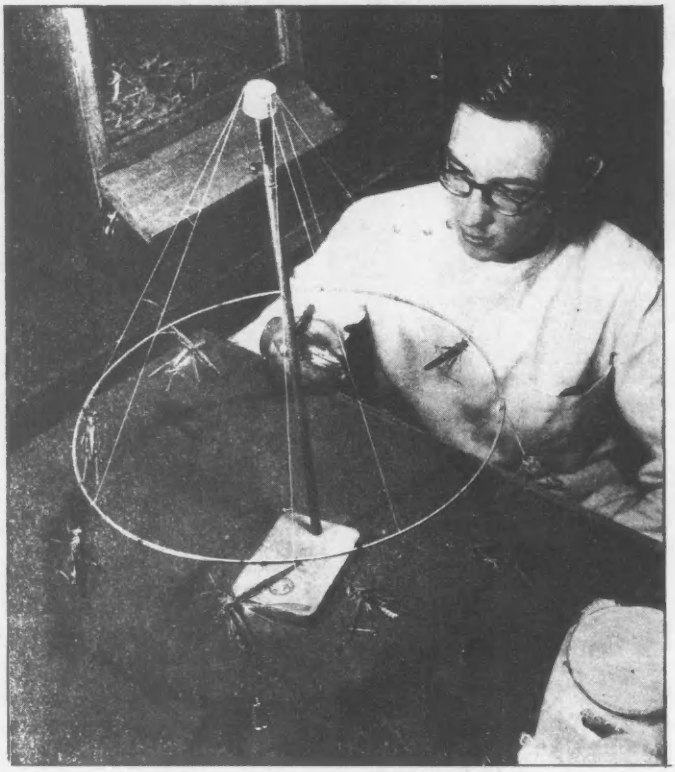

Fig. 4. Locusts, suspended on wire loops, perform an artificial "merry-go-round" flight.

author (Bei-Bienko, 1930), as a result of studies of habitats of transseasonal species of locusts, and currently supported by numerous examples among other insects, other invertebrates, birds and mammals. In the fourth place the seasonal change of stations in gregarious locusts in foci of massive eruptions necessitates a new appraisal of the population dynamics of locusts in these foci; the change in numbers in one or another of their populations occurs not only under the action of controlling ecological factors, but is also due to their displacement over the whole territory where foci of massive eruptions occur .

The Statistical Section of the Antilocust Center has two basic tasks: assistance in the determination of accuracy of experiments, and analysis of data collected in field and laboratory investigations. D. E. Davies is the head of the Section, and he has one assistant.

The library is an essential link in the work of the center; it contains about 10,000 editions on different problems of study of locusts and leaf hoppers and on methods of their control, (excluding work on systematics);

doubtless, this is the largest collection in the world of reprints and books on acridology. There is a division and species card index. The library staff consists of four, including the chief librarian E. N. Ralphs.

The Antilocust Center published a large number of different scientific works. Large works are published in the series "Antilocust Bulletins", of which 30 issues appeared since 1948, and in "Antilocust Memoirs", of which 5 issues appeared since 1946. Large numbers of works are published in various journals and in other editions, and some of the reprints are circulated by the Center as "Antilocust Reprints" of which about 210 appeared since 1946; these include the work not only by members of the Center's staff, and persons working at the Center, but also that done in other laboratories by extramural research workers who are financed by the Center.

In addition to this, starting in 1952, brief Reports of the Director, Antilocust Research Center, on locust research and control, are published annually; these reports also provide information on regional antilocust organization with which the Center is in contact and whose work it coordinates. The reports include the information starting in 1951. The period previous to this is covered in a separate publication by B. P. Uvarov, "Locust research and control 1929-1950", Colon. Res. Publication, No. 10, London, 1951. It summarizes antilocust campaigns, international collaboration in the research and control of locusts, and, briefly, the progress of scientific knowledge during this period.

Two stencil publications are to be also noted. The first is "Acridological Abstracts" which, starting from 1949, gives references to worldwide literature (except systematics) on Acrididae, Tettgoniidae and Gryllidae.. As of September 1958, 2264 papers have been reviewed. The second is "Current Research on Orthoptera", published in 1958. The first issue listed 215 investigators from 37 countries; over 70 workers should be added to this date.

The Antilocust Research Center performs a large and useful service by the publication of these reference works. It facilitates one's orientation in the current rapid flow of acridological investigations from different countries. H. B. Johnston's Annotated Catalogue of African Grasshoppers, Cambridge, 1956, published for the Antilocust Center, is to be noted as well. This catalogue is a key to the study of African locusts and literature on them, (see author's review in Zool. Zhurn. 35, 2, 1958).

This article could not have been very detailed, and does not cover all that makes the Antilocust Research Center a scientific biological organization; the author, undoubtedly, has been somewhat biased toward the aspects which most coincide with his own interests. However, everything stated above shows how complex and diverse the locust problem is, and how widely and completely it is being tackled; the Antilocust Research Center affords one an opportunity to see many interesting and instructive things in this connection.

FIRST INTERNATIONAL CONFERENCE FOR INSECT PATHOLOGY AND BIOLOGICAL CONTROL IN PRAGUE, AUGUST 13-18, 1958

I. A. Rubtsov

The First International Conference for Insect Pathology and Biological Control took place in Prague from the 13th to the 18th of August, 1958. August 100 delegates, representing 17 countries and 2 international organizations for biological control of insects, (International Organization for Biological Control and British Commonwealth Institute for Biological Control), took part in the conference. In addition to the representatives from all the European peoples' democracy countries, there was also present the representative from the Chinese Peoples' Republic, (from the Laboratory for Useful Insects, Entomological Institute of the Chinese Academy of Sciences). From the Western nations, specialists from Austria, Belgium, Great Britain, France, Federal German Republic, Switzerland, Italy, Yugoslavia, Canada, USA, Sweden, etc. took part in the conference.

The Czechoslovak delegation was naturally the biggest. There were 3 delegates from USSR, who were sent by official organizations, and 5-6 others came as tourists. Of the eminent Western workers Prof. Franz (Director of the Institute for Biological Control of the FGR), Prof. Simmonds (Director of the British Commonwealth Institute for Biological Control), Prof. Steinhouse (Department of Biological Control and Insect Pathology Laboratory, University of California), Dr Ferrier and Dr. Mesnil from Switzerland, Prof. Garnham from England, and others were present. The organizers of the conference were Dr. Ya Veizer of the Insect Pathology Laboratory, Czechoslovak Academy of Sciences and Dipl. Ing. Guba, Director of the Slovakian Plant Protection Station.

The conference was very well organized. The multiplicity of languages was overcome by a number of interpretors who translated one of the six languages of the speaker, (Czech, Russian, German, English, French, Italian), into the other five. Members of the audience heard the communication in their own language through a special system of radiotechnical translation, and earphones. The sessions took place in the ballroom of the International Hotel , specially equiped for this purpose. Most of the delegates lived in this hotel.

The organizers formulated the basic tasks of the conference as follows.

1) To discuss the most important problems and forseeable research projects in insect pathology and to outline organizational measures for further successful development of such investigations.

2) To discuss the most important problems related to the use of entomophagous animals in biological control of insects, (systematics, problems of introduction and acclimatization, increasing the effectiveness of entomophages, etc.).

3) To outline the organization of international collaboration in the research on and the use of entomophages; to improve personal contacts between workers in this field and, most important, contacts between organizations and institutions of the East and the West, between the newly emerging centers of the Eastern nations and the British Commonwealth Institute for Biological Control and the International Commission for Biological Control.

The meeting was opened at the appointed time by Ivan Malik, academician of the Czechoslovak Academy of Sciences, with a communication on the subject of biological investigations in socialist countries, especially

on the use of entomophages for biological control, and the consequent necessity for international collaboration. About 70 communications and papers on general and specialized biological and organizational problems were read at the conference. The underlying theme in all general and specialized communications, especially those dealing with organizational problems, was this: insects do not recognize international and political boundaries; many of them, including the most harmful ones, are widely distributed in the Old and the New Worlds; international collaboration is essential for modern successful control of these insects, both in scientific investigations and in the practical use of useful entomophages.

The 70 communications were divided into 10 sections: microbiology, mycology, helminthology, taxonomy, results of introduction, virology, protozoal diseases, increase of effectiveness, use of monophages and polyphages, the present state of affairs and perspectives in the use of entomophages.

The sessions took place not simultaneously but consecutively, so that every participant could attend any lecture.

Without attempting to recapitulate the substance of all the lectures, we shall outline only some of the most interesting features and present the resolution adopted by the conference; the resolution reflected the most important results of the work of this conference.

Of interest is the parallel development and independent discovery of certain general and specific facts, especially in the field of microbiology, to which a lot of attention was devoted, as compared with insects, due to the significance of microorganisms and, apparently, to the personal interests of the organizers of the conference. Thus, investigators both in the Eastern and the Western nations discovered similar new facts and came to some common conclusions. These are that virulence and pathogenicity cannot be equated to one another in different strains of the same microorganisms. It has been simultaneously and independently established that virulent strains of bacteria are characterized by the presence of crystalloid inclusions in their protoplasm; the question of synergism between microorganisms and insects is attracting attention in all parts. Ideas about the necessity and possibility of selection and of increased effectiveness of different strains of microorganisms or of different biological forms of useful entomophagous insects are also arising at the same time in all parts. Microbiologists and entomologists agree that the most important point in the study of entomophages is an exact diagnosis and an exact recognition and differentiation not only of specific, but also of intraspecific forms. This highlights the fact that no country has a sufficient number of specialized systematists and biologists who could by themselves solve even the primary problems of taxonomy which arise in connection with the practical use of entomophages. International collaboration is necessary in the use of entomophages for practical biological control. Useful organisms are considered everywhere as a productive force of the country, and their acquisition is at present a pressing problem. A lot has been done in this direction, especially in Canada and the United States. As an example the following, which was reported at the conference, may be quoted. In the United States two special factories are being built for the production of entomopathogenic bacteria. Even now 0.5 kg of bacteria costs only a few cents. One acre requires 1 to 200 grams of bacterial to condition it against harmful insects. Thus, even today a safe and a selective treatment of fields with microorganisms instead of insecticides which destroy biocoenosis, is technically possible and immeasurably cheaper. Biological control everywhere is only starting to be applied, but according to speakers its possibilities are unlimited. Western Europe, (FGR, France, Italy), are following Canada and the United States in this respect. The oldest organization of this kind is the British Commonwealth Institute for Biological Control, founded in 1928, i.e., about 30 years ago, and having branches in Paraguay, California, Europe and even in Western India, in the Himalayas. The task of the last-named branch, (in the Himalayas), as related to me by the director, Prof. Simmonds, is to obtain Eurasian entomophages, in other words those which mainly occur on the territory of USSR, and are alledgedly impossible to obtain from us by any means. Unfortunately, completely false impressions of the USSR, and particularly of its laws regarding the import and export of insects, are still prevalent in the West. It has been asked whether it is possible to send a postal parcel containing insects to the USSR and to receive such a parcel from the USSR.

Countries of peoples' democracies – Czechoslovkaia, Poland, Bulgaria, – are also vitally interested in the development of entomophage research in connection with its practical use. Thus, in Bulgaria, according to the speaker, there are 4 groups of workers on biological control who envisage a further development in their activity, as is also the case in Yugoslavia, FGR and France.

The resolutions of the conference, briefly, reflect the present state and problems of research on and the use of entomophages for biological control.

The basic and the most substantial points contained in these resolutions may be summarized as follows.

Mycology. To further research on certain entomophagous fungi. To establish an international center for the identification of entomophagous fungi. To develop methods of more effective artificial reproduction of entomophagous fungi. To make experimental studies of synergisms between fungi, insecticides and certain inert substances.

Bacteriology. It is imperative to establish regional collections of entomopathogenic bacteria. The following places have been recommended for their deposition; Parasitology Laboratory in Prague, Pasteur Institute in Paris, University of California in Berkeley. It is more important to study the factors which stimulate pathogenicity of bacteria in insects.

Virology. To further studies by means of electron microscopy of systematics, biology and histopathology. To establish virus collections in three centers: Canada (Bergold), Kiev (Gershenzon), California (Steinhouse). To study conditions which activate latent viral infections, i.e., chemical or biological agents. Due to the difference of pathogenicity of viruses it is desirable to conduct research on cross infections among intercontinental and intraregional populations of viruses.

Protozoology. To devote special attention to the raising of standards in the study of systematics and in the biological study of species. Each new description must be accompanied by an addition to the type collection in one of the centers of research on the protozoal agents of insect disease.

Helminthology. To perfect culture methods, to devize artificial culture media, to study relationship of helminths to bacteria.

Entomophagous insects. Exact identification is most important in all work. At present this is hampered by the paucity of specialists in any individual country, by their uneven distribution among different groups, by the absence of specialists on some groups of these insects, and sometimes by the insufficient training, and by the isolation of systematists either on the international scale or within a single country. It is recommended to plan the work of systematists in each individual country; the work of individual systematists must be reported in international publications; the study of type specimens and mutual examination of material in every country must be guranteed by reciprocal visits and quick publication; it is necessary to train specialists on groups which are insufficiently known. Bringing the work of systematists closer to practical problems is an assurance of the increasing necessity and significance of their activity.

Introduction and acclimatization. Having noted the considerable success of introduction of entomophages in the subtropics and in North America, the conference decided that the best results may be obtained by the introduction of entomophages from Eurasia. In order to increase the chances of successful introductions it is necessary to further research in systematics, biology, biocoenotic relationships and geographical distribution of pests and entomophages. It is also necessary to work out methods of collection, culture, maintenance, transport and use of entomophages. To facilitate transport of entomophages it is necessary to modify certain postal and quarantine regulations, to restrict quarantine limitations to import and not to export. Scientific organizations must be allowed to post entomphages by air mail without special permits. The introduction of terrestrial entomophages must be supplemented by intraregional distribution and by selection of suitable forms.

Increase in effectiveness of entomophages may be attained, first of all, by changes in agrochemical methods, e.g., use of poisons if they are harmless to entomophages, and by technique and methods of their use, (changes of dosage, local distribution, etc.). It is recommended to apply special agrotechnical measures which would conserve and increase the populations of entomophages in nature, (plowing, harvesting, sowing of food crops, preservation of accessory hosts, protection of entomophages in winter, etc.); selection and hybridization of individual effective populations; increase in effectiveness of entomophagous insects with the aid of viruses, bacteria, fungi and protozoa.

In Europe and in Asia, especially in USSR, there is an untapped wealth of entomophages for biological control in temperate regions of the whole world. In North America, (Canada and USA), there already exists a considerable experience in the use of entomophages, with which it is vitally important for us to become acquainted,and to apply it, as far as possible, in our country in order to protect and to increase crop production.

REVIEWS AND BIBLIOGRAPHY

THE SOVIET LITERATURE ON OESTRIDAE S. LAT. (DIPTERA) PUBLISHED IN 1957

K. Ya. Grunin

The Soviet literature devoted to oestrids in 1957 comprised 65 titles. This considerably exceed the number of titles for any previous year and is particularly impressive if one bears in mind that in the literature published up to 1917 no more than 122 titles appeared, including works published abroad by Russian investigators and translations and abstracts of foreign works published in Russia. From 1917 to 1956 inclusive 534 papers were published.

Table 1 shows the distribution by content of the 1957 papers.

In this table each paper is cited in only one column, corresponding to the principal emphasis of the work; naturally, the scope of many papers was considerably broader and the table is consequently subjective to a certain degree.

There follows a very brief survey of the more interesting data published in 1957, beginning with the warbleflies, to which more than 2/3 of the papers were devoted.

TABLE 1

	Systematics	Morphology	Biology	Injury	Control measures	Total
Oestrids in general					2	2
Warbleflies			12	6	29	47
Nose gadflies	1	2	2	1	6	12
Stomach gadflies				3	2	5
	1	2	14	10	39	66

TABLE 2

	Formation of warble		Drop off of larvae	
	Young	Adults	Young	Adults
H. bovis larvae	February 2	February 22	March 29	April 25
H. lineatum larvae	Insufficient data	February 6	Insufficient data	March 23

Doszhanov (523)* published valuable data on the biology of the ox warblefly (Hypoderma bovis De Geer) and the heelfly (H. lineatum De Vill.) – warbleflies of cattle. He established the existence of difference in the duration of larval development from the time of fistula formation to drop off, depending on the species of fly and the age of the host. On experimental animals in the south of the Dzhambul Region the duration of development of all larvae was determined with the help of numbered cloth bags attached to the sores. The adoption of relative dates** greatly simplified the processing of the results obtained and the calculation of

*In parentheses, after the name of an author who published more than one work in 1957, the first page of the paper is given in order to specify the reference.

**Relative dates – ordinal numbers of the days making up the period of investigation.

mean dates. The principal results of the lengthy and painstaking investigation of Doszhanov are shown in Table 2.

According to this table, 1) in adult animals, as opposed to young ones, the larval development of the warblefly is considerably delayed; 2) on adult animals, the development of ox warblefly larvae as opposed to those of the heelfly, is considerably delayed; 3) the mean duration of ox warblefly larvae development from the time of fistula formation to drop off on adult animals was 62 days, while that on young animals was no more than 55 days; 4) the mean duration of heelfly larval development on adult animals was 45 days.

The data show objectively for the first time that differences exist in the phenology of the two species of warbleflies and, furthermore, they enable one valuable conclusion to be made; between the 25-30 day interval between warble control treatments now being practiced a 40-day interval should be interposed. Romashova also arrived at the same conclusion after having carried out an investigation by similar methods in the Kirgiz SSR.

Romashova's paper also presented some other very interesting data on the biology of warbleflies of cattle. It has been considered until recently that the termination of larval migration in the body of the host (their emergence under the skin of the back), the formation of a connective tissue cyst around them, the formation of a perforation through the skin of the animal, and the first molt coincided in time. According to Romashova's observations, however, the larvae which have just ceased migration appear under the skin of the back at the beginning of July; this time coincides with their first molt and with the beginning of the formation of the connective tissue capsule and the warble in the skin. The thick capsule is formed considerably later and the perforating fistula is not formed before the middle of September.

Under the oesophageal mucous membrane of two adult animals Romashova found 4 lineatum first-instar larvae. The theory that some of the heelfly larvae penetrate the body of the host through the mouth is based on some indirect evidence; part of this is provided by observations of first-instar larvae not only in the walls of the intestine, but also under the mucous membrane of the oesopagous.

Romashova was the first person in the USSR to have located a point of aggregation of males of lineatum and bovis. All points of aggregation of cattle warbleflies known in Western Europe are permanent.* It is entirely likely that in the future special observations carried out in this location will reveal much of interest.

Mustafaev (62), at the Baku meat combine, determined that in Azerbaidzhan heelfly larvae are found in the alimentary canal of cattle throughout the year, without showing substantial variation in numbers. The situation he observed is apparently determined by the fact that the cattle investigated were both from the mountain and lowland areas of the republic, where the developmental cycle of the heelfly differs strongly. In the southern mountainous regions of the USSR investigations of the developmental cycle of cattle warbleflies are essential, but their execution must be irreproachable in matters of methods.

Ermachenkov found 45 ox warblefly larvae in 8 horses put out to pasture with cattle; he succeeded in rearing the adult fly from one of the larvae. Until now such an event was only postulated in the literature. Mamedov and Aliev observed warbles from fly larvae (species undetermined) in many buffalo of various ages. It had been previously noted in the Russian literature that warbleflies died under the back skin of buffalo, not forming any wargles. Brudnaya in Chita and Épshtein in Astrakhan described one case each of parasitism by cattle warbleflies in man. In each case the larvae parasitized a child of 7 years, in small numbers; some of the larvae completed migration by emerging under the skin of the head. Aside from those just mentioned, 20 cases of myiasis caused by warbleflies are known in the Russian literature; in only 4 cases in man was there more than one larva involved; in 19 cases myiasis was recorded in children (from 2 to 13 years old, inclusive); in 19 cases the emergence of the larva was observed in various parts of the head (7 of these inside the eyeball).

A series of papers by Potemkin and his co-workers and Khatin and his co-workers is devoted to the testing of "chlorophos".** methoxychlor, and other compounds for combating the larvae of the ox warbleflies and heelfly. On the application of subcutaneous injections of chlorophos the data are conflicting so far; Potemkin, Gil'denblat, and Pavlova (94) note the death of young larvae but an absence of effect on third-instar larvae; con-

*The biological propensity for male warbleflies to collect in a definite spot ensures the meeting of the sexes even when they are present in extremely low numbers in nature.

**Perhaps chlorthion – translator.

versely, Voronin and Ivashkov (76) arrived at directly opposite conclusions. Nevertheless, it is precisely from the method of subcutaneous injection of insecticides that a solution of the problem may be expected.

1957 saw the publication of results of new investigations on the biology of Oedemagena tarandi L. and the improvement of control measures against it. Breev and Karazeeva established the presence of a positive chemotropism in the females of Oedemagena for the smell of reindeer urine. This fact provides the basis for the belief, widespread among reindeer breeders, that the flight of Oedemagena is oriented to the north. It is known that in the spring the reindeer herd migrates in a northern direction, shedding Oedemagena larvae along the way. It is not unusual for females emerging from these larvae to find the reindeer by the smell of urine left by the herds on their way. Some facts have been published characterizing the extent of the injury caused by Oedemagena to reindeer farms. The infection of reindeer by necrobacillosis is in direct relationship to the degree of disturbance caused in the herd by the female Oedemagena. Mezenev established the fact that in a herd in which control measures had been carried out against female Oedemagena, deaths from necrobacillosis among the reindeer was reduced by 2.8 times as compared with an untreated herd; unfortunately the number of reindeer in either herd was not specified and hence it remains unclear to what extent the data are comparable. According to Nikolaev, Preobrazhenskii, and Boblikova, there was not one single case of necrobacillosis in a herd which had been subjected to Oedemagena control; unfortunately, the authors did not mention the extent of necrobacillosis in untreated herds. Vostryakov and Savel'ev found it possible to reduce the insecticide content in water emulsion from 2% DDT and 2% BHC to 1.3% DDT and 1.3% BHC without reducing the effectiveness of spraying reindeer against females of Oedemagena. Savel'ev published a description of the sprayer "Sever" which he constructed and which weighs no more than 8 kg, with a capacity of 6-8 l per minute. In the roadless tundra, lowering the concentration of insecticide in emulsion and the creation of a new sprayer will greatly facilitate the control of Oedemagena.

Moskalenko published a short note on the discovery of warblefly larvae in mouse hare, suslik, and bobac in Mongolia; the latter appears for the first time among the hosts of warbleflies. The species of warblefly was not indicated by the author; evidently the larvae discovered were not preserved.

The 1957 literature on nose gads was primarily devoted to the testing of control methods against the sheep nose gadfly (Oestrus ovis L.) which had been proposed by native investigators during the preceding years. Knorre published some very interesting observations on the biology of the moose nose gad (Cephenomyia ulrichi Br.). In particular, he describes the exceptionally quick reaction of the attacking female gadfly to the defensive head movements of the moose. Before scattering larvae into the nostrils of the moose the female hovers for some time in the air at a certain distance from the nostril. The most rapid movements of the head of the frightened moose not only do not rid it of the fly, but do not even succeed in changing the latter's position with regard to the nostrils; to use Knorre's own graphic expression, one gets the impression that the moose's head and the female gadfly are firmly united by an invisible wire. It may scarcely be doubted that this rapid responding reaction the female fly enables her to scatter the larvae infallibly in the nistril of the moose.

In 1954-1955, in the Rostov Region Kukalov determined that 2.55% of sheep livestock were infested with sheep gadfly. Such facts are deseriving of the most careful consideration, since special investigations on the extent of material damage caused by gadflies and especially nose gads have not been carried out, even though the necessity for this sort of work is evident. The absence of such investigations hinders the elaboration of control measures against gadflies and to an even greater extent hinders the adoption of the measures already elaborated.

Few works were published on stomach gads in 1957. Grab (157), carrying out experiments on Gastrophilus intestinalis De Geer and G. veterinus Cl., ascertained that the introduction into the blood stream of sensitized horses (those having experienced larval infestation) of an insignificant amount of aqueous larval extract led to the onset of anaphylactic shock in the horses. Kholodii described a case of creeping eruption* which he successfully cured with a DDT paste in glycerine.

In 1957, great contributions were made to the study of oestrids. It is to be hoped that the coming years

* A disease caused by the migration of first-instar stomach gladfly larvae in the skin of man. The colloquial name of "porikozha" (from "porot' kozhu" – rip skin) was introduced into the literature by the doctors Vostrikov and Bogrovyi in 1909.

will prove no less productive and that they will be marked by the appearance of very necessary investigations on the anatomy of oestrids and on the economic injury which they cause.

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